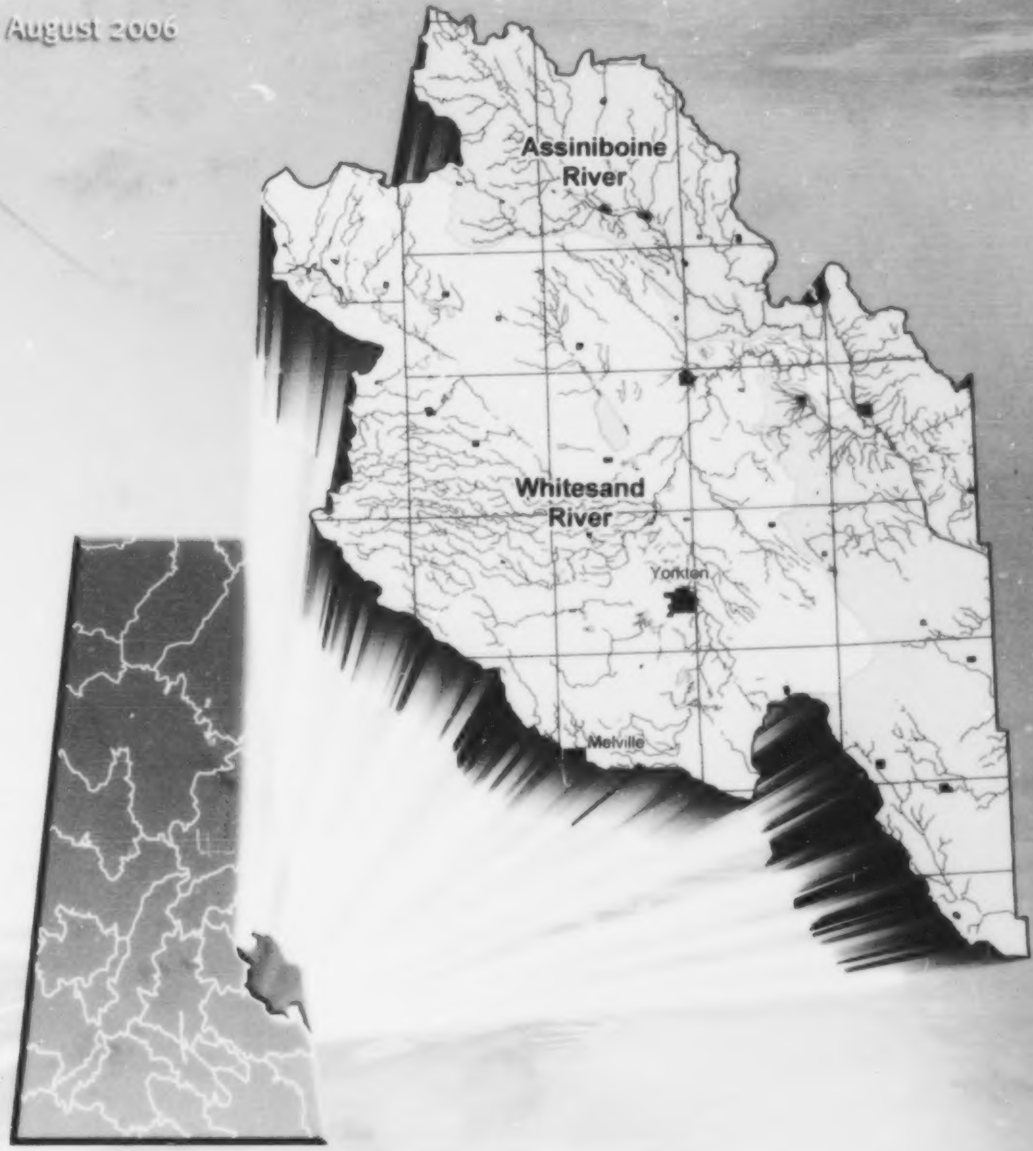
Assiniboine River Watershed

Source Water Protection Plan

August 2006


Assiniboine River
Whitesand River
Yorkton
Melville

Saskatchewan
Watershed
Authority

Assiniboine River
Watershed Advisory
Committees

2007-00001

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1. Executive Summary

The Assiniboine River and its tributaries are located in eastern Saskatchewan and western Manitoba. Within Saskatchewan, the Assiniboine River Watershed covers an area of 17,300 square kilometres and includes 24 rural municipalities, eight towns, 15 villages and the cities of Melville and Yorkton.

The focus of this plan, consistent with the Saskatchewan's *Safe Drinking Water Strategy*, is to protect source waters in the Assiniboine River Basin within the Province of Saskatchewan. The purpose is to summarize the current status of water resources, identify risks to water quality, and describe an action plan to ensure the sustainability of water in the Assiniboine River Watershed.

The Assiniboine River Watershed Source Water Protection Plan was developed by the Assiniboine River Watershed Advisory Committees, with support from the Assiniboine River Watershed Technical Committee and in consultation with watershed residents. Watershed and Aquifer Planning staff from the Saskatchewan Watershed Authority facilitated the planning process over a two year period.

Source water protection is considered the first barrier in the multi-barrier approach to attaining safe drinking water, and is viewed as the most cost-effective means of ensuring the safety of drinking water.

In October 1996, the governments of Saskatchewan, Manitoba and Canada agreed to conduct The Upper Assiniboine River Basin Study. The study was initiated as a result of the 1995 flood and other issues, including drainage and flood control and the disappearance of valuable wetland habitat. In addition, there was uncertainty regarding sustainable water supplies for municipal, industrial, agricultural and recreational purposes and a lack of knowledge regarding the hydrologic and ecological processes and their effects within the watershed. There was also growing concern that the quality of water was deteriorating, and uncertainty about appropriate measures for aquifer management and protection. The Upper Assiniboine River Basin Study provided information respecting the Basin's water resources, and information and recommendations on which to base decisions affecting future water management.

The Saskatchewan Watershed Authority was established on October 1, 2002 to manage and protect water quantity and quality within the province. As part of this mandate, the Saskatchewan Watershed Authority is responsible for managing watershed and aquifer planning in Saskatchewan. In 2004, two Watershed Advisory Committees were established within the Assiniboine River Watershed to lead the planning and decision-making process. Their work built upon the Upper Assiniboine River Basin Study, with a focus on source water protection.

The development of a management strategy for a watershed normally begins with the assembly of basic watershed information into an overview or background report. The Upper Assiniboine River Basin Study was utilized extensively to develop a background report for the Assiniboine River Watershed.

The Upper Assiniboine River Basin Study was also used to prepare a list of the areas of concern related to source water protection. All of the issues contained in the Upper Assiniboine River Basin Study were reviewed from a source water protection perspective. These concerns and issues were then separated into "water quality", "watershed health" and "wildlife" issues. This was considered the starting point of the new process. The Assiniboine River Watershed Advisory Committees were then consulted to ensure that the list of concerns and issues was complete, and additional issues were added by the Committees.

As mentioned earlier, the focus of this process was on developing a protection plan for drinking water. Thus, it was decided to first concentrate on community-based drinking water sources, as opposed to individual systems. The latter are to be addressed through such programs as the Environmental Farm Plan program, or within the context of the larger community-based source waters.

It is estimated that nearly 90 percent of residents within the Assiniboine River Watershed use groundwater, as opposed to surface water. In contrast to surface water, the groundwater supply in the watershed is more stable. However, groundwater supplies are typically not sufficient to provide large quantities of water at any given location. Defining the available groundwater supply is more involved and costly than doing the same for surface water.

A risk analysis workshop for the combined Technical Committees of the Assiniboine River Watershed and the Yorkton Area Aquifers planning process was held over a two day period. The committees first screened the issues and sorted them with respect to their relevance to source water protection. This process transformed the list of issues into "risk areas". Then a scan and scope of each area of risk was conducted by the group.

Some key observations made at the conclusion of the risk analysis process were that:

- agriculture is by far the dominant land use within the watershed, and as such agriculture ranked as a higher risk than the other risk areas;
- there is a split between what urban and rural residents feel has the largest impact on water quality, and that residents in each area feel that the other is not assuming sufficient responsibility;
- the water quality of the Assiniboine River is generally good and that, while there may be reaches that are being negatively impacted, these are few and not widespread;
- currently there are no apparent serious, widespread risks to water quality resulting in source water degradation in the watershed quantity; and
- a major threat or stressor to water quality in the Assiniboine River Watershed is excess nutrient inputs, principally nitrogen (N) and phosphorous (P). This is common to many other watersheds that are dominated by agriculture.

Once the priority risk areas were identified, the next steps of the watershed planning process were to develop objectives to address these risks and then to formulate recommendations and key actions to fulfill those objectives.

Key strategies identified

The following key strategies are not listed in any specific order.

1. Formation of a formal Assiniboine River Watershed Authority (or Conservation District or Source Water Protection Authority). This is a critical component to the successful implementation of the Source Water Protection Plan. It is vital that the implementation of the watershed planning process be carried out under the premise of local ownership. A local manager will provide an exclusive focus to local issues and initiatives.

2. Protect the source drinking water for all communities by developing a well head integrity program for every community that uses groundwater (including community wells owned by Rural Municipalities) and protecting the water quality upstream of surface water intakes.

3. Improve fish passage throughout the Assiniboine River Watershed. An absence of barriers allows for migrations of fish and other species, and results in greater biodiversity and stability throughout the watershed. Fish are a major component of the aquatic system. Taking steps to ensure that desirable fish species are present in the system also encourages people to care for the aquatic system and take the necessary measures to protect water quality.

4. A nutrient reduction plan to reduce nutrient loading associated with human activities that result in the movement of nutrients to water bodies within the watershed is a strategy that affects all residents within the watershed. Every sector should contribute toward the nutrient reduction plan for the watershed. This is viewed as a collaborative initiative and does not assume or place blame on any particular sector.

5. Increasing the education and awareness of residents about their watershed and related watershed issues is seen as a key priority for the Assiniboine River Watershed.

Ensuring the safety of their drinking water is the responsibility of every resident living in a watershed. Everyone has some impact on water quality. Because good water quality is necessary for human life, and because it is vital for sustaining a health economy, it is incumbent on all residents to act in a responsible and sustainable manner.

The Assiniboine River Watershed Technical Committee strongly recommends that the Government of Saskatchewan support, both financially and technically, these evolving Watershed Advisory Boards so that the objectives, recommendations and key actions identified herein will be achieved. This is seen as a vital course of action if the Source Water Protection Plan is to proceed to the implementation phase.

A policy must be developed to address the future interactions with existing "water-related" groups, such as the Yorkton Creek Watershed Association or the Good Lake Conservation and Development Area Authority. These groups have been in place for years and are responsible for the operation and maintenance of many water control works within the watershed.

This plan is not intended to be the complete and comprehensive solution for source water protection in the Assiniboine River Watershed. Instead, the intent is to direct initial strategies for the newly formed watershed organization. These strategies will be based on the issues with the highest potential risk with respect to source water protection.

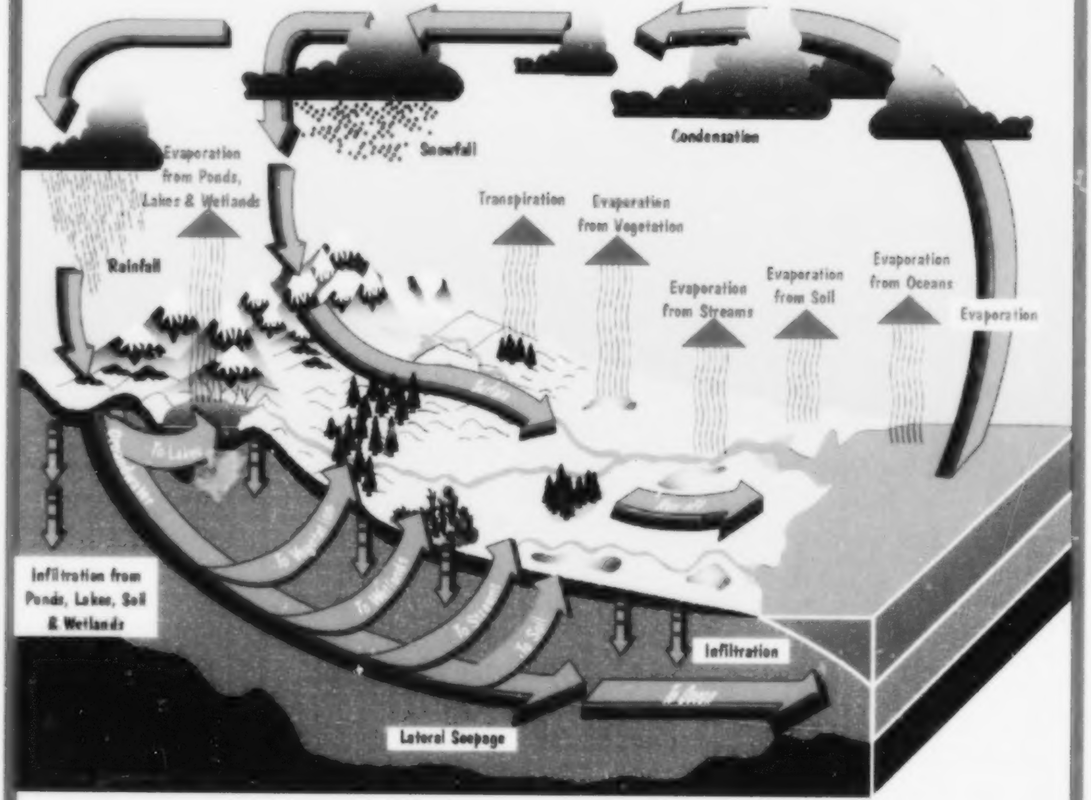
2. Introduction to Source Water Protection

Abundant, clean, safe drinking water is a basic need for human life. Saskatchewan residents have long taken for granted the safety of their drinking water. However, following the water quality problems experienced in Walkerton and North Battleford that view has changed – not only in Saskatchewan, but also across the rest of Canada. Ensuring the safety of our drinking water is the responsibility of all residents living in a watershed.

Throughout Canada, provinces and municipalities have adopted various strategies to ensure access to safe, abundant drinking water. In Saskatchewan, this included adopting the *Safe Drinking Water Strategy*. A basic premise of this strategy is that it is easier, more effective, and more efficient to prevent contamination of source water than it is to remove contaminants at water treatment facilities. Thus, source water protection is the first barrier in a multi-barrier approach to ensuring safe drinking water. Other barriers include the effective treatment and distribution of water.

When considering source water protection, a fundamental understanding of how water moves through the environment is necessary. Examination of the hydrologic cycle (Figure 1: The Hydrologic Cycle), or water cycle, demonstrates the many routes that water can take as it travels between the atmosphere, the ground, rivers, lakes and the ocean. On the earth, water moves across the surface and through the ground as groundwater. Water may also be stored for long periods in wetlands, lakes, and especially as groundwater. The journey may be complicated and convoluted, but the movement of water through the cycle is never-ending.

THE HYDROLOGIC CYCLE


Evaporation from Ponds, Lakes & Wetlands
Snowfall
Condensation
Transpiration
Evaporation from Vegetation
Rainfall
Evaporation from Streams
Evaporation from Soil
Evaporation from Oceans
Evaporation
To Lakes
To Vegetation
To Wetlands
To Streams
To Soil
Infiltration from Ponds, Lakes, Soil & Wetlands
Infiltration
Lateral Seepage

Powered by solar energy, water circulates endlessly from the atmosphere to land and back to the atmosphere. Water evaporates from oceans, circulates with the atmosphere, condenses within clouds and is eventually precipitated as rain or snow. Most of the water that falls on the land returns to the oceans by surface run-off and groundwater seepage. Flow on its return to the ocean maybe temporarily stored in wetlands, lakes and glaciers. Within this major system are many smaller cycles, such as evaporation and transpiration from plants.

Figure 1: The Hydrologic Cycle

In highly altered landscapes such as the Assiniboine River Watershed, there are many potential contamination threats and many access points of these threats to water quality. These threats have increased as a result of constant ecosystem alterations by humans.

In order to manage water resources in a sustainable manner, the following question must be addressed: What activities and what intensity of activities will negatively impact water quality and water quantity? Also, what is the combined effect of different activities on water quality and quantity? In other words, at what point are we stressing the ecosystem beyond its capacity to assimilate these activities?

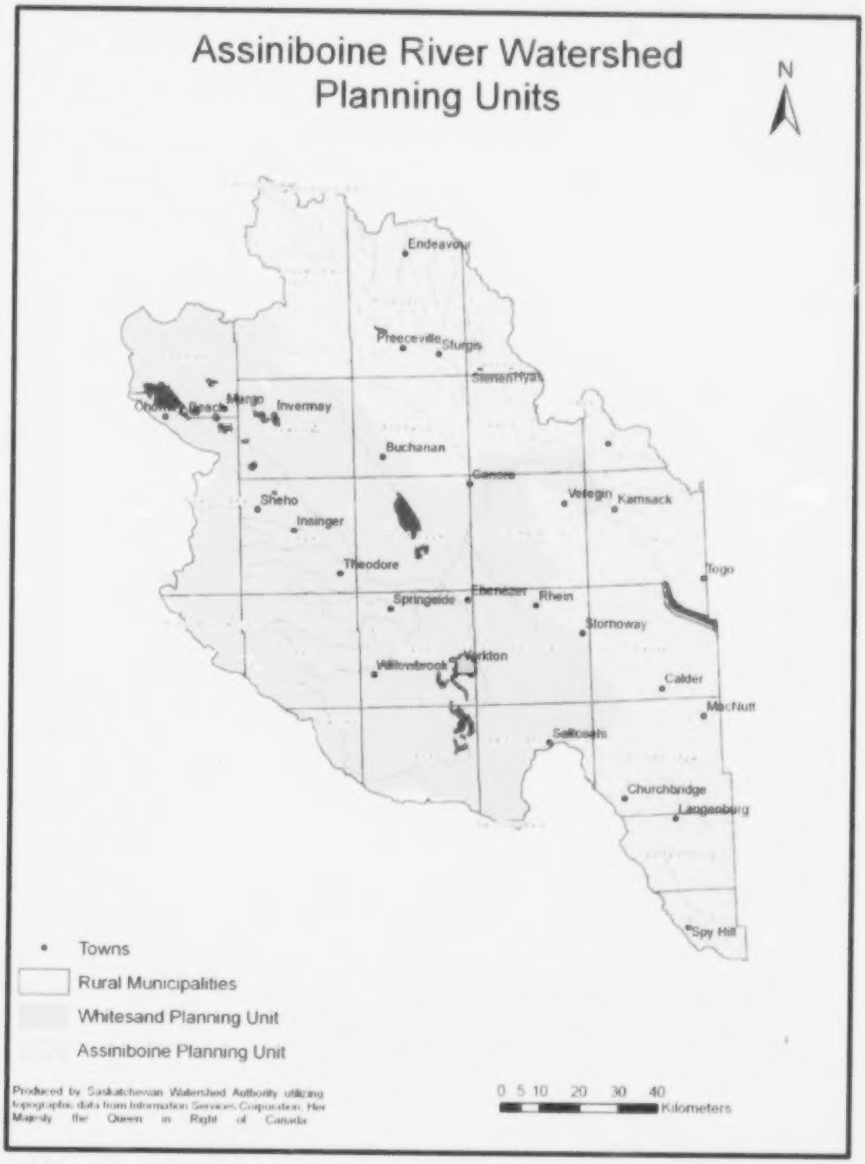
The objective of this plan is to summarize the current status of water resources, identify risks to water quality, and describe an action plan to ensure the sustainability of source water in the Assiniboine River Watershed. This process was driven by local residents with support from technical experts in Saskatchewan. Developing a plan that will result in the maintenance of a healthy watershed is an excellent means of attaining the first barrier for the sustainable protection of our source water and move Saskatchewan to the successful implementation of its *Safe Drinking Water Strategy*.

3. Introduction to the Assiniboine River Watershed

The Assiniboine River and its tributaries are located in eastern Saskatchewan and western Manitoba. The Assiniboine River Watershed covers an area of 17,300 square kilometres within Saskatchewan. This area includes 24 rural municipalities, eight towns, 15 villages and the cities of Melville and Yorkton (see Figure 2).

The headwaters of the Assiniboine River are about 50 kilometres (km) northwest of Preeceville in the Porcupine Hills. The Whitesand River originates in the Beaver Hills northwest of Yorkton, then joins the Assiniboine River near Kamsack. Other major tributaries located within Saskatchewan are Lilian River, Smith Creek, Crescent Creek, Willow Brook, Wallace Creek, Kamsack Creek, Stony Creek and Yorkton Creek. Several natural lakes are found within the watershed, the most notable of which are Good Spirit Lake, Fishing Lake, and the series of small, interconnected lakes south of Yorkton which include York, Roussay, Leech, and Crescent Lakes.

From Kamsack the Assiniboine River continues southeast for another 45 km before entering Lake of the Prairies near the Manitoba border. Lake of the Prairies is a reservoir 56 km in length straddling the Saskatchewan-Manitoba border. Shellmouth Dam, which creates Lake of the Prairies, is located 35 km downstream of the provincial boundary.


Assiniboine River Watershed Planning Units
N
Endeavour
Preeceville
Sturgis
Stenen Hyas
Beach
Margo
Invermay
Buchanan
Canora
Veregin
Kamsack
Sheho
Insinger
Theodore
Togo
Springside
Ebenezer
Rhein
Stornoway
Willowbrook
Yorkton
Calder
MacNutt
Saltcoats
Churchbridge
Langenburg
Spy Hill
Towns
Rural Municipalities
Whitesand Planning Unit
Assiniboine Planning Unit
0 5 10 20 30 40
Kilometers

Produced by Saskatchewan Watershed Authority utilizing topographic data from Information Services Corporation. Her Majesty the Queen in Right of Canada

Figure 2: Administrative Boundaries

Upper Assiniboine Basin Wildlife Summary

The Basin supports a diverse wildlife population including approximately 240 bird species, 50 mammal species, three reptile and five amphibian species (see the Upper Assiniboine River Basin Study, Appendix C, Wetlands Committee Report).

- White-tailed deer are the most common ungulate, inhabiting the hills, valleys and aspen bluffs. Elk and moose are also present, but are less common, although their numbers are increasing significantly in some areas.
- The Upper Assiniboine River Basin is an important breeding area for waterfowl in the prairie region of Canada. The diversity in types of wetlands, abundance of permanent wetlands, and increased water stability compared to more arid southerly regions, allow for more consistent waterfowl production.

- The Upper Assiniboine River Basin has a diverse fish community, with established populations of 32 species of fish (See Appendix C: Fish Species of the Assiniboine Basin.) Common species include northern pike, walleye, perch, burbot, and mooneye. A small member of the lamprey family, the chestnut lamprey, has been collected at several locations in the Basin. The chestnut lamprey is listed as "vulnerable" by the Committee on the Status of Endangered Wildlife in Canada. This listing means that the species is not in current danger, but is of special concern due to characteristics that make it sensitive to human activities or natural events.
- Water bodies in the Assiniboine River Basin that are of particular importance to the local sportfishers include many of the larger lakes such as Good Spirit, Stoney and Fishing Lakes. These lakes typically contain a variety of species, including those actively sought by anglers such as northern pike, walleye and perch. Lake of the Prairies, a man-made reservoir, supports the largest sport fishery in the Basin.

Photo courtesy of Nature Saskatchewan
Lakes provide important recreational and economic opportunities.

The dominant land use in the Assiniboine River Watershed is agriculture, with 58% of the total land used for annual crops, as indicated in the following table.

Land Cover	Percent Cover
Cropland	58
Grass	17
Trees	14
Shrubs	5
Wetland	5
Large Lakes	1

Table 1: Land Cover
Data Source: 1990's Western Grains Transition Payment Program

The climate of the area is characterized by long, cold winters and short, warm summers. The mean annual temperature in the watershed is about 1°C. The normal frost-free season is typically from 90 to 110 days. Most of the moisture is provided by air masses originating near the Gulf of Mexico. The annual precipitation in the watershed averages about 450 mm, of which about 74 percent occurs as rainfall with the rest occurring as snowfall. The mean annual potential evaporation from a water body for the Yorkton area is 850 mm. The value for an extreme dry year is 1,090 mm.

The population of the portion of the Assiniboine River Watershed within Saskatchewan is approximately 45,500. The rural population represents about 34 percent of this total, with the urban or community population making up the remaining 66 percent. The City of Yorkton is the largest urban centre in the watershed with 37 percent of the total watershed population. The population of the City of Yorkton and the surrounding four Rural Municipalities (the Rural Municipality of Orkney No. 244, the Rural Municipality of Cana No. 214, the Rural Municipality of Wallace No. 243 and the Rural Municipality of Saltcoats No. 213), including the towns and villages therein, comprises 50 percent of the total watershed population.

Economic activity and land use in the watershed are dominated by mixed grain farms, with pasture and hay lands common. Small livestock operations can be found throughout the study area. The development of feedlots and other intensive livestock operations is becoming more frequent throughout the watershed. Traditionally, the beef cattle industry has dominated the livestock sector; however, there has been a relatively recent increase in intensive hog production.

The average farm size has increased over the last 40 years. The rural population is declining, while urban populations have remained relatively steady.

Industrial activity in the watershed is generally localized in the larger urban centres and is predominantly agricultural-based. Other industrial activities include the potash and petroleum sectors as well as meat packing plants, concrete manufacturing, bakeries, and publishing facilities.

Photo courtesy of Saskatchewan Agriculture and Food
Agriculture is the major land use in the watershed.

Surface Water Summary

Typical of most prairie streams, the Assiniboine River displays peak flows during the spring as a result of snowmelt. The flow rapidly decreases to a small base flow derived from groundwater. Typically, this base flow persists throughout the summer as shown in Figure 3, although historically the river has occasionally run virtually dry.

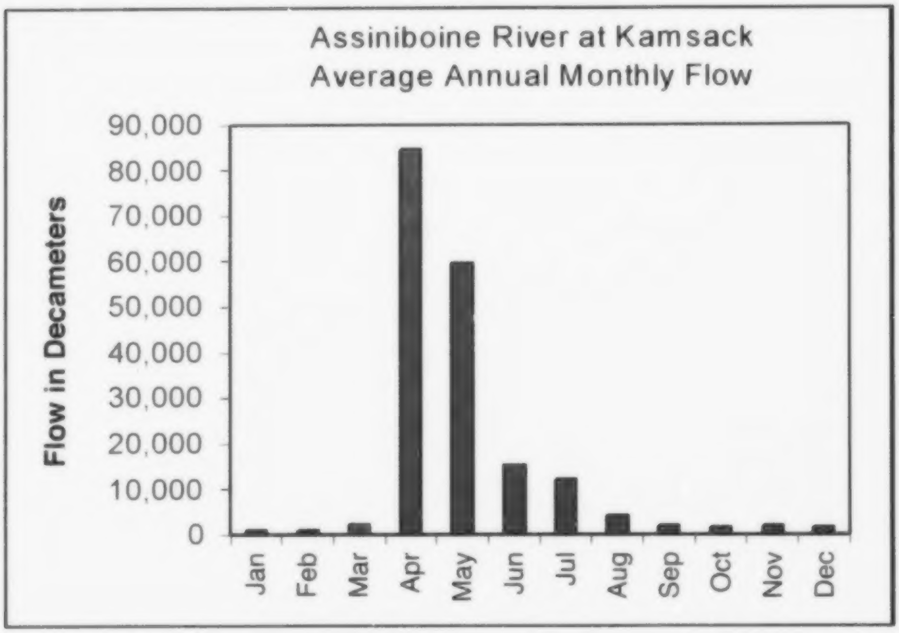


Figure 3: Assiniboine Average Annual Monthly Flow

In an average flow year, 77% of the runoff volume occurs in the months of April and May.

The Prairie Provinces Water Board (PPWB) was established by the governments of Alberta, Saskatchewan, Manitoba and Canada to monitor flow apportionment among the three Prairie Provinces. They have developed what is termed as 'natural flows' (flows that would have occurred under natural conditions prior to the intervention of man) for the Assiniboine River at the provincial boundary.

The surface water supply for the Assiniboine River Watershed is extremely variable during the year, as shown above in Figure 3. It is also highly variable on a year-to-year basis. Between 1912 and 2005, the annual streamflow has ranged from a historical low of 17,000 dam^3 in 1989 to a recorded maximum of 1,471,000 dam^3 in 1922. The last major flood occurred in 1995 and had a flow of nearly 900,000 dam^3. Figure 4 shows the high variability in flows that may occur annually.

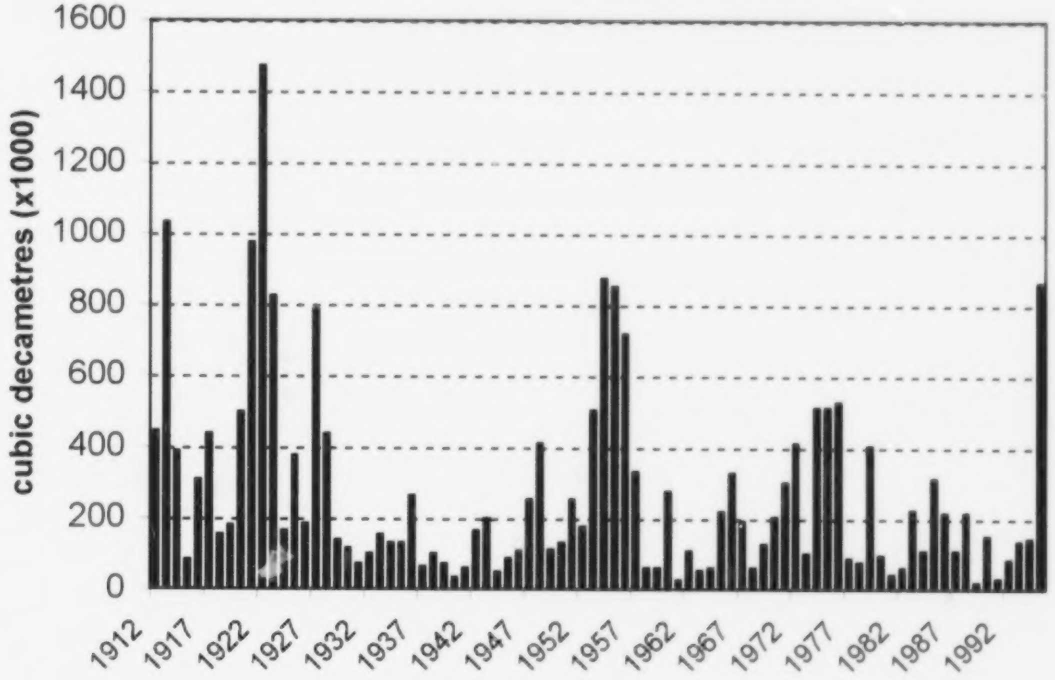


Figure 4: Mean Annual Natural Streamflow at the Provincial Boundary

The mean annual natural flow of the Assiniboine River at the provincial boundary is calculated to be 265,000 dam^3. The apportionment would be 50 percent value (50 percent of the flow must be passed to the Province of Manitoba, as is outlined in the Prairie Provinces Water Board agreements). This translates to a volume of 132,500 dam^3.

The quality of the larger sources of surface water in the Assiniboine River Watershed is generally acceptable for most uses. However, some smaller water bodies may have marginal water quality, a trait common to the prairie region. The water's suitability for specific uses varies with these smaller water bodies. Sometimes the poor water quality has been attributable to human activity, while at other times it is due to natural conditions, such as soil characteristics.

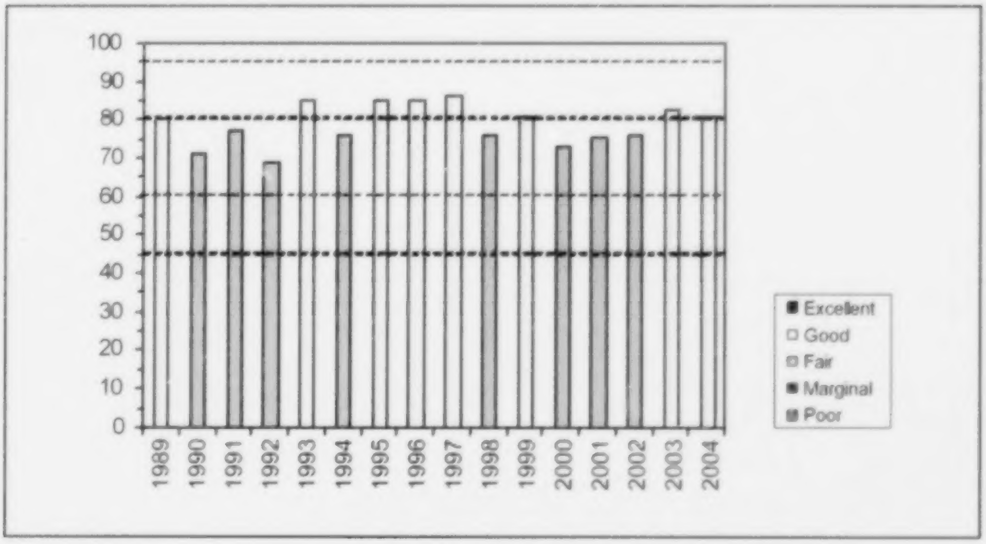


Figure 5: Water Quality Index rating for watershed protection at Kamsack on the Assiniboine River

Dashed lines correspond to WQI ratings 95-100 = 'Excellent', 80-95 = 'good', 60-80 = 'fair', 45-60 = 'marginal', less than 45 = 'poor'

The table below summarizes the parameters and objectives used to calculate the Water Quality Index rating.

Category	Water Quality Parameter	Non-compliance objective
General	pH Dissolved Oxygen (DO) Chlorophyll *a* (Chl *a*)	< 6.5 or > 8.5 < 5.0 mg/L > 50 μg/L
Dissolved Solids and Major Ions	Total Dissolved Solids (TDS) Dissolved Sodium (Na^+) Dissolved Chloride (Cl^-) Sulphate (SO_4^{2-})	> 700 mg/L > 100 mg/L > 100 mg/L > 500 mg/L
Nutrients	Total Phosphorus (TP) Nitrate/Nitrite (NO_3^-/NO_2^-) Total Ammonia Nitrogen (NH_3)	> 0.1 mg/L > 1.0 mg/L pH and temp. dependent¥
Heavy Metals	Total Arsenic Total Aluminium Total Chromium Total Mercury	> 50 μg/L > 5 mg/L > 20 μg/L > 0.1 μg/L
Pesticides	2, 4-D• MCPA§	> 4 μg/L > 25 μg/L
Microbiological	Fecal Coliforms	> 1,000 cfu*/100 mL

¥ *The objective value for total ammonia nitrogen varies with temperature and pH. When temperature is less than 300C and pH is less than 9, the objective concentration of un-ionized ammonia is less than 33 μg/L.*

• *2,4-Dichlorophenoxyacetic Acid.* § *MCPA, dimethylamine salt.* * *Colony forming unit.*

Table 2: Water Quality Index Parameters and Objectives

Groundwater Summary

In contrast to surface water, groundwater in the watershed is less prone to variability due to short term precipitation extremes, and thus as a supply it is more consistent. However, groundwater supplies are typically less able to provide large quantities of water at any given location. Groundwater can be contained in one of two general geologic deposits: bedrock and glacial. Aquifers in bedrock are deeper and tend to be more extensive in area than those in glacial deposits. For purposes here, glacial aquifers occur as buried valleys, inertial or surficial aquifers. Groundwater supplies not in surficial aquifers are insulated from drought conditions at surface, while even surficial aquifers may offer some measure of drought resistance because of the storage in the aquifer.

Available groundwater supply, unlike surface water supply, cannot be directly measured. Therefore, defining the groundwater supply is more involved, arduous and costly than doing the same for surface water. The complete characterization of groundwater resources, even for a simple system, requires significant amounts of data and skilled data interpretation. For an area as large and hydrogeologically complex as the Assiniboine River Watershed, a complete characterization would require great amounts of data and equal amounts of skilled data interpretation, resulting in a very expensive effort. Thus, this hasn't been accomplished as yet and there are no plans to do so in the foreseeable future. However, considerable mapping has been completed, providing the mapping framework to understand groundwater. This mapping continues to be developed and periodically improved, although in an ad-hoc fashion.

Groundwater resources in the Assiniboine River Watershed are classified as both bedrock and quaternary aquifers. Bedrock aquifers are composed of sands of the Mannville/Swan River Formation and Undifferentiated Tertiary-Quaternary sands. The saturated sands of the Tertiary-Quaternary sediments consist of the Bredenbury, Otthon, and Willowbrook aquifers. These aquifers range in thickness from 20 to 30 meters, overlain by 20 to 130 meters of till. The Bredenbury and Otthon aquifers are hydraulically connected to the Hatfield Valley aquifer system.

Aquifers in the glacial deposits are formed in buried valleys, intertill, and surficial deposits. Buried valley aquifers in the watershed include the Hatfield Valley, Basal, Melville, and Rocanville aquifer systems. The Hatfield Valley aquifer system is the most extensive in the area and extends into Manitoba. It is one of the largest buried preglacial valleys in Saskatchewan. Typical thickness of the Hatfield Valley aquifer is 50 meters, overlain by approximately 50 meters of till. The Melville and Basal aquifers occur above the "shoulder" of the Hatfield Valley, with an estimated thickness of 20 to 30 meters. The Rocanville aquifer ranges in thickness from 10 to 125 meters, overlain by 75 to 150 meters of glacial drift.

Intertill and surficial aquifers are characterized as discontinuous sands and gravels. Intertill aquifers are confined above and below by till deposits. These types of aquifers are referred to as undifferentiated intertill and intratill aquifers. The spatial extent, distribution, and thickness of these aquifers are variable. These aquifers provide an important source of water for both domestic and municipal purposes. For example, the City of Yorkton production wells are mostly completed in the inter- and intratill aquifers. Surficial and alluvial aquifers include sand and gravel lenses and alluvial deposits. The major alluvial deposits are related to the Qu'Appelle and Assiniboine river valleys.

Water Usages

Municipal water use is defined as that occurring in cities, towns, villages and hamlets that are serviced by a distribution system. Commercial and industrial users that are serviced by municipal lines are considered to be municipal water users. There are 27 communities in the watershed that have water systems, serving populations ranging from 21 to over 15,000. There are also a number of park facilities with licensed water allocations that are categorized as being municipal water users for the purposes of this plan. The total current annual use by municipal water users is estimated to be 4,930 dam^3, of which nearly 90 percent is supplied from groundwater sources. The water use by community is shown in Table 3.

Community	Source	Water Use (dam^3/yr)	
		1998	5 Yr Avg (1994-1998)
Badgerville (Cote)	SW	31*	31*
Bredenbury	GW	46.3	47.3
Buchanan	GW/SW	61.2*	61.2*
Calder	GW	13.3	9.8
Canora	GW	280	278
Churchbridge	GW	107*	107.1
Ebenezer	GW/SW	16.7	17.5
Endeavour	GW	66.7	63.0*
Fenwood	GW/SW	3.4	3.7
Gerald	GW	16.8	17.2
Hyas	GW	24.7	21.2
Insinger	GW	0.7	0.8
Invermay	GW	43.2	39.4
Jedburgh	GW	1.9	1.7
Kamsack	SW	315	279
Ketchen	SW	1.6*	1.6*
Kuroki	SW	8.9	9.8
Langenburg	GW	153	155
Lintlaw	GW	45.8	43.7
MacNutt	GW	12.2	12.7
Margo	GW	26	27.6
Melville	GW/SW	643	633
Mikado	GW	5.8	5.3
Preeceville	GW	206	222
Rama	GW	9	8.7
Rhein	GW	18	22.5
Saltcoats	GW	102	92.5
Sheho	GW/SW	26.8	30.3
Springside	GW	63	69.4
Spy Hill	GW	39.9	37.5
Stenen	GW	16.6	15.9
Sturgis	GW	134	145
Tadmore	GW	2.2	2.8
Theodore	GW	123	97.3
Togo	GW	24.9	23.1
Veregin	GW	9.9	8.2
White Spruce	GW	12	12
Willowbrook	GW	6	6*
Wroxton	GW	7.5	6.3
Yorkton	GW	2114	2160
Hamlets[1]	GW	55*	55*
Parks Facilities[2]	GW	41*	41*
Saskatchewan Totals			

Table 3: Municipal Water Use in the Assiniboine River Watershed

*Notes: *,1 & 2 are estimates*
City of Melville is using 75% groundwater

The following table summarizes the annual uses by sector.

Type of Use (% of Total Use)		Saskatchewan (dam^3/year)		
		SW	GW	Total
Municipal (15%)	Recreation	0	40	40
	Urban Distribution	540	4,360	4,900
	Total Municipal	540	4,400	4,940
Agriculture (26%)	Irrigation	2,120	30	2,150
	Livestock			2,540
	Domestic			1,400
	Spraying			240
	Evaporation	2,140		2,140
	Total Agriculture			8,470
Industrial (10%)	Food Processing	0	30	30
	Cavern Washing	0	1,940	1,940
	Mining	0	1,380	1,380
	Total Industry	0	3,350	3,350
Wildlife Conservation (50%)		16,640	0	16,640
Reservoir Evaporation (negative 1%)		-360	0	-360
Total				33,040

Table 4: Summary of Present Licensed Withdrawal Uses (dam^3/year)

SW is Surface Water, GW is Groundwater
Values have included some estimated values

Note: the negative value for Reservoir Evaporation is due to the lowering of the spill elevation at Good Spirit Lake when SaskWater and the Good Spirit Lake Watershed Association constructed an outlet structure on the lake in the late 1980's.

Wildlife Conservation is an allocation based on 57 'constructed' wildlife projects in the watershed. The allocation was calculated by determining the evaporative loss for each project. This 'use' was to ensure that the allocated water is not available for alternate uses because of the licensing.

The total usage for surface water sources, excluding wildlife and reservoir evaporation, is estimated to be 4,800 dam^3/year. This value is only 1.8 percent of the total 265,000 dam^3 estimated for the mean surface flow at the provincial boundary and 3.6 percent of the apportionment volume of 132,500 dam^3 for a mean annual year as determined by Prairie Provinces Water Board, as outlined above. The surface water usage value increases when wildlife conservation allocation is considered. While this is a non-consumptive use of water, it is necessary to account for the water needed by wildlife so that over-allocation of consumptive uses does not remove too much water from the system.

The total licensed allocation for both surface and groundwater is calculated to be 33,040 dam^3/year. When this value is compared to average surface water supplies it seems apparent that there is an adequate supply of water in the watershed.

In extreme low-flow years, such as 1961 or 1989, the natural flow was calculated to be approximately 17,000 dam^3. During these years there is adequate surface water overall, excluding wildlife and reservoir evaporation. However, when wildlife use is considered the estimated total use is 21,080 dam^3, which is above the extreme low flow value. It is likely there were shortages experienced in the aquatic ecosystems and hardships for some residents in the watershed as well.

In the Upper Assiniboine River Basin Study, a mathematical water management model was used to examine the state of the surface water and the major water uses in the Basin on a monthly basis. The analysis revealed that:

- at both the current and future level of water use, surface water supply is generally sufficient, although it is less reliable in the headwaters of the Basin. As with all prairie areas, the Basin is subject to droughts.
- a preliminary analysis of instream flow requirements suggests that water is generally available for aquatic ecosystems and offstream uses. However, during periods of low flows there may be conflict with other water uses.
- apportionment between Saskatchewan and Manitoba is not an issue in the Basin at the present time or in the foreseeable future.

4. Watershed Planning Methodology

Interests and Issues Identification

The Upper Assiniboine River Basin Study reports were used extensively to prepare a list of concerns related to source water protection.

All of the Upper Assiniboine River Basin Study issues were reviewed from a source water protection perspective. This focus lead to initial concerns among some Assiniboine River Watershed Technical Committee members, who stated that source water is not the only requirement in need of consideration. One particular concern was the perceived need to further explore the relationship between watershed health and wildlife health.

For the purpose of this watershed planning process, it was concluded that *the focus must be on source water protection* and those aspects of the ecosystem that are strongly linked to this aspect. If a protection strategy also has a benefit to wildlife it may be considered an additional advantage; however, it was not the focus of this planning process. It should be stressed that wildlife and habitat can be ideal indicators of ecosystem health and the ability of a watershed to provide quality water for human use.

It was also decided to organize the "water quality" issues and concerns identified in the Upper Assiniboine River Basin Study separately from the "watershed health" and "wildlife" issues. Additional considerations or issues raised by the Watershed Advisory Committees were then added.

The following section summarizes the specific watershed considerations or issues pertaining to source water quality and quantity that were identified in the Upper Assiniboine River Basin Study or added by the Watershed Advisory Committees.

Water Quality

1. Watershed residents perceive that groundwater and surface water quality is deteriorating and that it must be better protected, which includes enhancing our understanding of the systems by increasing the intensity of monitoring.
2. Rural residents are concerned about access to good quality domestic and drinking water supplies and the availability of low cost testing services.
3. Domestic and municipal groundwater supplies need to be protected from contamination.
4. Chemical container disposal areas and landfill operations are point sources of pollution that can affect surface and groundwater quality. These operations must be properly managed, and regulations must be enforced.
5. Agricultural drainage from farm land, sloughs and wetlands can be a non-point source of pollution of surface water. Agricultural runoff may contain increased sediment, nutrients and pesticides.
6. Algal blooms on Lake of the Prairies are a concern.
7. Livestock operations and improper range management practices deteriorate water quality and impact downstream users.
8. Municipal lagoon operations, sewage treatment and effluent releases can impact water quality and must be strictly managed.
9. Urban stormwater runoff may affect the water quality of rivers and streams downstream of communities.
10. Flooding.

Watershed Health

11. The economic and social considerations associated with wetlands and agriculture should be better understood.
12. Wetlands and uplands in the watershed are important and should be protected. The continued degradation and removal of wetlands and riparian areas in upland regions may lower overall watershed health and may also place wildlife at risk.
13. Land and water management practices affect fish habitat.
14. Increased bank erosion of streams and rivers diminishes water quality. Increased erosion and sedimentation reduces fish spawning areas and habitat.
15. Conflicts between land use for agriculture and wildlife habitat should be resolved to give better direction for water management.

16. The oil and gas industry is perceived as a threat to surface and groundwater in the watershed.
17. The development of future regional waste management sites may be of local concern to water quality.

Water Quantity

18. Surface water supplies may not be adequate to meet future water demand.
19. Groundwater demand could exceed the sustainable groundwater supply.
20. The current and future ability to make use of available water may be limited by the state or scale of the required infrastructure.

Analysis of Current Watershed Management Issues/Considerations

The Assiniboine River Watershed Technical Committee was charged with analysing the issues from the Upper Assiniboine River Basin Study. Technical Committee members first reviewed the information and data contained within the Upper Assiniboine River Basin Study to determine its relevance to the current planning process and provide advice on whether new information was available or required.

The Technical Committee also sought to:

- determine whether or not regulations apply to each issue, and under what circumstances they apply;
- identify the agency(s) responsible for administering these regulations;
- provide a copy of current regulations;
- determine what, if any, policies are also being used in the management of these issues and whether the policies have any impact on how the applicable regulations are enforced;
- evaluate whether available research and/or data can demonstrate the relevance of these issues to source water protection; and
- compile an inventory related to the issue (for example, the number of Intensive Livestock Operations within the watershed), with the ultimate goal of having this data accessible in a Geographic Information Systems (GIS)-friendly format.

Expert guest speakers were invited to provide detailed information within their discipline to better inform the Technical Committee on specific issues and how they relate to source water protection.

Details of the issue analysis prepared by the Technical Committee is included in Appendix E: Assiniboine River Watershed Issues Analysis on the CD attached to this document.

During the initial phases of the planning process, it quickly became apparent that a process to review and evaluate these issues was needed. It was felt that the issues should be prioritized according to the level of risk each presented to the watershed's source water.

Risk Assessment Analysis

Dr. Terry Hanley, Director of Watershed Monitoring & Assessment with the Saskatchewan Watershed Authority, was contacted to advise on methods of scientifically assessing the relative risk each issue posed to source water. Dr. Hanley suggested using a method of "Risk Assessment - Evaluation of Issues" that he developed as part of his doctoral research in risk assessment. This procedure has previously been used by the United States Environmental Protection Agency and other agencies around the world. It was presented to the combined Technical Committees of the Assiniboine River Watershed and the Yorkton Area Aquifers planning processes at a two-day risk analysis workshop led by Dr. Hanley.

The risk assessment analysis used the following process:

> The Technical Committee first screened the issues and sorted them with respect to their relevance to source water protection. It was also decided that issues related to each other should be combined. This process transformed the list of issues into "risk areas".
>
> The following were determined to be the principal risk areas for the Assiniboine River Watershed:
>
> - Agriculture (non-point pollution)
> - Livestock (all aspects)
> - Roadways
> - Urban stormwater
> - Municipal wastewater
> - City of Yorkton wastewater
> - Oil and gas industry
> - Road salt
> - Landfill sites
> - Chemical container sites
>
> The next step was to determine the scope of each risk area. This involved evaluating each risk area by:
>
> - describing the stress, exposure, and response relationships;
> - determining its extent within the watershed (i.e. whether the risk area is localized at one site, or whether it is pervasive throughout the watershed);
> - establishing whether there is an increasing, decreasing or stable trend of risks;
> - identifying the primary stressors; and
> - pinpointing the exposure pathways for each risk.

Table 5 highlights the risk areas identified during the discussions.

Agriculture

- Nutrients [nitrogen (N) and phosphorus (P)], pathogens (manure applications), erosion/sediments, pesticides

Livestock

- Nutrients (N and P), pathogens, erosion/sediments, pharmaceuticals

Roadways

- Erosion/sediments, agricultural runoff, hydrocarbons

Urban Stormwater

- Nutrients, pathogens, hydrocarbons, suspended solids, pesticides, heavy metals . . . we do not have a feel for the relative concentration of these constituents (infomation gap to be filled later this year)

Municipal Wastewater (Lagoons)

- Nutrients (N and P), pathogens, suspended solids, acute total ammonia concentration
- Discharges are biannual (for Melville), annually, every second year, as needed or rarely if ever

City of Yorkton Wastewater

- Nutrients (N and P), pathogens, pharmaceuticals, chronic and acute total ammonia concentration
- Daily discharge, 24 hours per day

Table 5: Risk Area Constituents

The group then assigned a severity score of Minor, Adverse, Serious or Critical, for three different categories: Health Criteria, Ecological Criteria, and Socio-Economic Criteria.

Based on the above, risk factor scores were calculated and a final score was assigned for each risk area. Table 6 summarizes the scoring.

Risk Area	**Category**
Agriculture (non-point contamination)	Moderate
Livestock (all aspects)	Moderate
Roadways	Low
Urban Stormwater	Low
Municipal Wastewater	Low
City of Yorkton Wastewater	Low
Oil and Gas	Very Low
Road Salt	Very Low
Landfill Sites	Very Low
Chemical Container Sites	Very Low

Table 6: Analysis of Potential Risk for the Assiniboine Basin

Notes:

- *The analysis focussed more on surface water than on groundwater.*
- *Each item was discussed and debated thoroughly to reach a consensus throughout the evaluation.*
- *Scientific knowledge was used whenever possible, and equally important, the collective knowledge of the group (there were 17 Technical Committee members involved) was used to conduct the risk assessment process.*
- *At the end of the two-day process the group felt that, although the process was not necessarily an exact scientific procedure, there was consensus on its validity and ultimately the conclusions that were reached.*
- *Several issues from the interests and issues identification exercise were excluded from this risk assessment analysis, but would still be analyzed in the issues analysis report prepared by both the Watershed Advisory and Technical Committees.*

Figure 6 compares the relative significance of the risk areas based on the scores determined during the evaluation. Risk scores for all of the risk areas are expressed as a percentage of the overall total score. Although these risks are not necessarily additive, the intent of the figure is to convey a measure of the relative potential of each risk area.

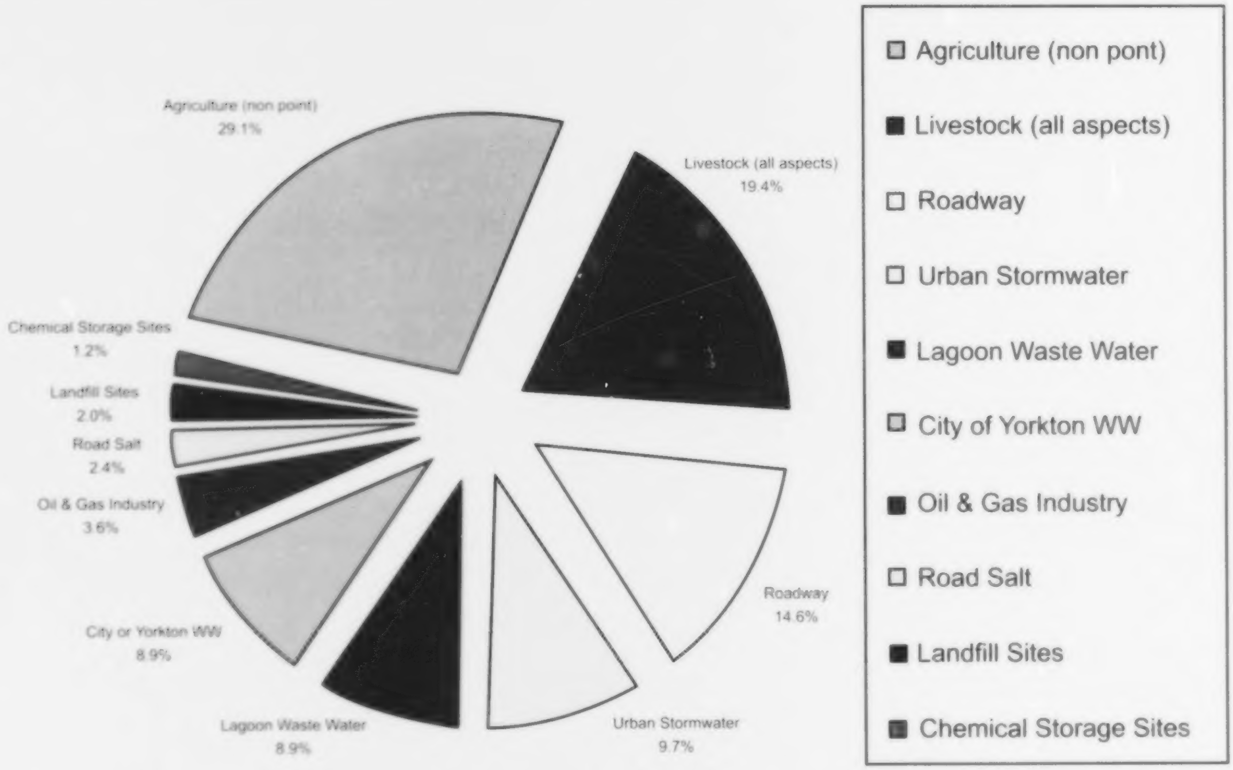


Figure 6: Comparison of Potential Risk for the Assiniboine River Watershed

Some observations made at the conclusion of the risk assessment analysis process were that:

- agriculture is by far the dominant land use within the watershed, and as such agriculture ranked as a higher risk than the other risk areas;
- there is a split between what urban and rural residents feel has the largest impact on water quality, and that residents in each area feel that the other is not assuming sufficient responsibility;
- the water quality of the Assiniboine River is generally good and that, while there may be reaches that are being negatively impacted, these are few and not widespread;
- currently, there are no apparent serious, widespread risks to water quality resulting in source water degradation in the watershed quantity;
- most people in this watershed use groundwater as a drinking source;
- a major threat/stressor to water quality in the Assiniboine River Watershed is excess nutrient inputs, principally nitrogen (N) and phosphorous (P). The addition of nitrogen and phospherous to surface water results in increased algal growth and decreased water quality. This is common to many other watersheds that are dominated by agriculture. Developing and executing a nutrient plan for the Assiniboine River Watershed is an obvious strategy to address this issue.

The Technical Committee recognized that analyzing every aspect of every issue would be prohibitively time consuming. Once implementation of the source water protection plan is initiated and the major topics identified through our risk analysis approach are addressed, it is assumed other issues that generated lower risk scores will be reassessed.

Thus, only the highest scoring risk areas (of low to moderate risk) are considered further in the Assiniboine River Watershed Source Water Protection Plan at this time. Objectives, recommendations, and key actions were only developed for these highest scoring risk areas.

The result of the risk assessment analysis was reported to the Watershed Advisory Committee members for their review and comments. After consensus was achieved between the Watershed Advisory and Technical Committees, the results were used to develop source water protection objectives, recommendations and key actions.

Assiniboine River Watershed Objectives, Recommendations, and Key Actions

Once the priority risk areas were identified, the next step in the process was to develop objectives to address these risks.

Objectives in this planning process were defined as being general statements of desired outcomes to be achieved over a similar but unspecified period of time. Normally in a planning process there are two to four objectives with a time frame of three to five years.

Finalizing the objectives required several iterations between the Technical and Watershed Advisory Committees before reaching consensus. The following table summarizes the five objectives of the Assiniboine River Watershed Source Water Protection Plan. The objectives are not in any order of significance or relevance.

Objective 1:	Empower the local watershed citizens to promote and implement a healthy watershed strategy.
Objective 2:	Protect source drinking water for all communities.
Objective 3:	Improve the health of aquatic ecosystems in the watershed.
Objective 4:	Improve the overall water quality throughout the Assiniboine River Watershed.
Objective 5:	Develop education strategies and increase awareness of source waters and their associated issues within the Assiniboine River Watershed.

Table 7: Assiniboine River Watershed Planning Objectives

Once agreement was reached among the Committees, the planning process focused on developing recommendations and key actions for each objective.

Recommendations are measurable, time-defined goals that are specifically subordinate to an objective. Usually there are seven to ten recommendations per objective. The time frame for the achievement of each recommendation is up to three years.

Key actions identify the specifics of what must be done to achieve each recommendation. These actions represent the means needed to achieve the goal stated in the recommendation. They tend to be fairly immediate steps and are more likely to be adapted to meet the goals of the process than are objectives or recommendations.

Once the Watershed Advisory Committee approved the objectives, they asked the Technical Committee to develop a list of recommendations and key actions that would address them. The Watershed Advisory Committee made this request because they felt the Technical Committee had the expertise to better prepare a comprehensive list of recommendations and key actions.

The Technical Committee met on several occasions to develop, review and discuss potential recommendations and key actions. After a list was developed, a joint meeting between the Technical and Watershed Advisory Committees was held to review and discuss the recommendations and key actions in order to reach consensus between these two committees.

The following is the list of the objectives, recommendations and key actions agreed to by both committees.

5. Watershed Planning Objectives, Recommendations, and Key Actions

Objective 1:

Empower the local watershed citizens to promote and implement a healthy watershed strategy.

Introduction

This objective is a critical component essential to the successful implementation of the Source Water Protection Plan. Having an Advisory Board and a Local Watershed Manager is an effective means for meeting watershed implementation strategies. It will promote a strong sense of direction, purpose and ownership, and ultimately provide the impetus to meet the identified planning goals.

It is vital that the implementation of the watershed planning process operates under the premise of local ownership. A local manager provides exclusive focus to local issues and initiatives and serves as the "go-to" contact for stakeholders.

The creation of an Advisory Board and the establishment of a Local Watershed Manager will serve to bridge and unify the efforts of various government and non-government agencies that individually address issues related to soil, air, water and wildlife. This concept provides a mechanism for these organizations to deliver their respective programs, while at the same time meeting the overall watershed planning objectives. The Local Watershed Manager will function as a broker to improve the health of our watersheds.

A Technical Committee, with a similar membership to which participated in the watershed planning process would be available to the Local Watershed Manager and to the Advisory Board.

The existing *Watershed Associations Act* will be used as the framework to form the new administration. New legislation may be needed in years ahead if administrative problems arise.

The Province of Manitoba has used a very similar model to this approach for the last 30-plus years and has been extremely successful, especially from the local support aspect.

Recommendation

1.1 Formation of a formal Assiniboine River Watershed Authority (or Conservation District or Source Water Protection Authority).

Key Action: Seek support from Watershed Advisory Committee members in forming the Assiniboine Advisory Board, and explore funding sources.

Time Frame	**Responsibility**
During 2006	Assiniboine Advisory Board* Saskatchewan Watershed Authority* Assiniboine River Watershed Technical Committee

Key Action: Hire a full-time Local Watershed Manager who would report to the Assiniboine Advisory Board.

Time Frame	**Responsibility**
By the end of 2006	Assiniboine Advisory Board* Saskatchewan Watershed Authority*

It is imperative that the implementation of the source water protection plan is guided by the local Assiniboine Advisory Board. The Local Watershed Manager, who reports to this Board, will be responsible for the implementation, but the Advisory Board will determine the direction of the implementation. The Technical Committee is to provide technical assistance as required. Securing long-term funding for the coordinator position is seen as critical to the success of the implementation process.

Objective 2:

Protect the source drinking water for all communities.

Introduction

The principal basis of this objective is to address community water systems, not necessarily individual sources of drinking water. These individual sources will be, at least in some scenarios, protected by actions intended to address community systems. In addition, there are other programs which address individual systems, including the Environmental Farm Plan program, the Saskatchewan Watershed Authority's Rural Water Quality Advisory program, and the water testing services available from Saskatchewan Health.

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* Indicates the organization(s) responsible for leading the key action

Any expectation that raw source water, whether surface or groundwater, will be potable without treatment is unrealistic. Although improved and enhanced source water reduces risks to human health and often results in lowering treatment costs, source water needs to be treated prior to human consumption.

Source water protection is the first level of a multi-barrier approach to protecting drinking water. To minimize the risk to source water in the Assiniboine River Watershed, a risk analysis was performed for the entire watershed and specific strategies were formulated to address those risks. This analysis provided the basis for the following recommendations.

Recommendation

2.1 Develop a well head integrity program for every community using groundwater including Rural Municipality community wells.

Key Action: Compile and collect existing well data.

Time Frame	**Responsibility**
2006	Saskatchewan Watershed Authority*

Key Action: Categorize the risk situation (i.e. low, medium, high) for all community wells. The aquifer will be categorized for its vulnerability at the well location.

Time Frame	**Responsibility**
2006	Saskatchewan Watershed Authority*

Key Action: Determine how Saskatchewan Environment's well head protection program could be used to enhance the well head integrity program.

Time Frame	**Responsibility**
2006	Saskatchewan Watershed Authority Saskatchewan Environment

Key Action: Increase site inspections and collect data from additional sites, specifically targeting community wells and aquifers.

Time Frame	**Responsibility**
2006 – 2011	Saskatchewan Watershed Authority* Individual communities and Rural Municipalities

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* Indicates the organization(s) responsible for leading the key action

Key Action: Develop programs to address the issues that arise from carrying out the above mentioned key actions.

Time Frame	Responsibility
2007 & forward	Assiniboine Advisory Board* Saskatchewan Watershed Authority* Assiniboine River Watershed Technical Committee

Recommendation

2.2 Protect water quality upstream of surface water intakes.

Key Action: Identify the surface water sources that are being used for community drinking water.

Time Frame	Responsibility
2006	Saskatchewan Watershed Authority* Assiniboine Advisory Board

Key Action: Develop site-specific or subwatershed plans for those communities using surface water as the source of their drinking water.

Time Frame	Responsibility
2007	Saskatchewan Watershed Authority* Communities Assiniboine Advisory Board

The following are examples of possible goals:

- Ensure the maintenance of healthy riparian zones/buffers along water courses to a specified distance upstream of the community's water intake.
- Ensure sufficient vegetative buffers exist around any waterbodies being used as community drinking water supplies.

Objective 3:
Improve the health of aquatic ecosystems in the watershed.

Introduction

Healthy aquatic ecosystems are those that can sustain human use and accommodate natural and human-caused disturbances, while still maintaining their structure and function. The term structure refers to the living and non-living components of the ecosystem – specifically, the species of animals, fish, insects, bacteria, plants and so on that are present, along with the water and substrate that form the habitat for these species. Ecosystem function refers to the processes that link these components together: for example, the flow of energy and matter through the food web, the migrations of various species, and how various species use the aquatic habitat to complete their life cycles.

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* Indicates the organization(s) responsible for leading the key action

Wildlife and wildlife habitat can be ideal indicators of ecosystem health, and the ability of a watershed to provide a sustainable source of quality water for human use. In addition, wetlands are instrumental to a healthy watershed.

It is not sufficient that the necessary components of the ecosystem are simply present at some place in the system; they must be accessible and available to the appropriate species when they are needed. Fish, as an example, require different types of habitat for spawning, rearing, feeding, and surviving through the winter. These different types of habitat are not usually present in close proximity but may be many miles apart. For a fish population to survive, grow, successfully reproduce, and be healthy, it must be able to reach different types of habitat at the appropriate times of year. However, there are often migration barriers that prevent fish from reaching critical habitat. Common barriers to migration are dams, weirs and low level crossings that are not designed to provide flow conditions for fish to swim through or over. One of the greatest concerns is barriers that stop fish from moving upstream during the spring spawning migration.

In general, the greater the number and variety of plant and animal species that are present, the more stable and healthy the ecosystem. An absence of barriers allows for migrations of fish and other species, and results in greater biodiversity and stability throughout the watershed.

Fish are a major and visible component of the aquatic system. Taking steps to ensure that desirable fish species are present in the system has the beneficial side effect of encouraging people to care for the aquatic system and take the necessary measures to protect water quality.

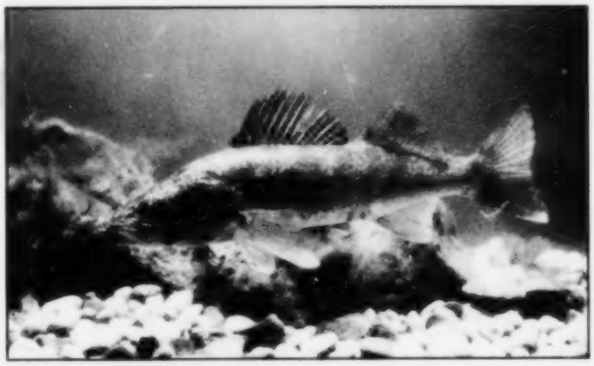

Photo courtesy of Fisheries and Oceans Canada.

Recommendation

3.1 Improve the connectivity of aquatic habitat, and in particular, improve fish passage throughout the Assiniboine River Watershed.

Key Action: Collect hydrological and fish passage data during the spring spawning season at selected obstructions.

Time Frame	Responsibility
Ongoing – 2007	Saskatchewan Watershed Authority* Fisheries and Oceans Canada Saskatchewan Wildlife Federation

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* Indicates the organization(s) responsible for leading the key action

Key Action: Conduct biological and engineering evaluations of potential fish barrier structures at the selected sites.

Time Frame	Responsibility
Ongoing – 2007	Saskatchewan Watershed Authority Fisheries and Oceans Canada

Key Action: Determine the best solutions to mitigate these barriers.

Time Frame	Responsibility
Ongoing – 2007	Saskatchewan Watershed Authority Fisheries and Oceans Canada Local governments Local landowners

Key Action: Prioritize, consult, and develop strategies for upgrading these sites.

Time Frame	Responsibility
Ongoing – 2007	Saskatchewan Watershed Authority Fisheries and Oceans Canada

Key Action: Seek funding, including from the original funding partners of the constructed works, to carry out the recommended mitigation works.

Time Frame	Responsibility
Ongoing – 2007	Saskatchewan Watershed Authority* Fisheries and Oceans Canada Saskatchewan Wildlife Federation Local governments

Key Action: Implement the recommended works.

Time Frame	Responsibility
2006 – 2008	Saskatchewan Watershed Authority Fisheries and Oceans Canada Saskatchewan Environment Local Landowners Assiniboine Advisory Board

Recommendation

3.2 Protect and improve riparian buffers along selected streams and stream reaches in order to protect aquatic ecosystems and water quality. An example key action:

- Identify locations where riparian buffers require enhancement or development.

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* Indicates the organization(s) responsible for leading the key action

Recommendation

3.3 In-stream work such as excavation and channelization should be avoided. Instream works to maintain existing drainage systems should be conducted in a manner that will minimize any impacts to aquatic systems and downstream water quality. Example key actions include:

- Drainage works should incorporate their existing natural elements to the greatest extent possible, such as wetlands and existing riparian vegetation.
- Mitigation of lost aquatic habitat may be an option. Mitigation may involve retaining, improving or restoring habitat to compensate for habitat that may be lost in developing a project that involves land drainage and/or clearing. This concept is applicable at both the small scale (individual farm level) and to a larger scale proposal (watershed level).

Objective 4:

Improve the overall water quality throughout the Assiniboine River Watershed.

Introduction

Overall, the water quality of the Assiniboine River is considered to be relatively good for a prairie river. There have been no significant trends observed in the overall water quality for the past 20 years at the Prairie Provinces Water Board monitoring site near Kamsack. There are no known environmental disasters occurring in the watershed.

It is probable that water in the Assiniboine River has been relatively nutrient rich for centuries, as is the case for many other water bodies and water courses in the Canadian prairies. Thus, it is unrealistic of this watershed planning process to set unattainable nutrient goals based on water quality objectives from other regions with different geology and lower nutrient loads, such as the Canadian Shield. It is also unreasonable to expect raw source water from the Assiniboine River to be potable.

One of the principal water quality concerns is the input of nutrients, sediment, chemicals and pathogens resulting from human activity. These inputs can either be from a single point (point source), or can occur over a wide range (non-point source). Both point source and non-point source contributions of pollutants within the Assiniboine River Watershed need to be assessed.

It is easier to assess the contribution and impact from point sources of pollution, such as sewage effluent, than it is from non-point sources. However, non-point source pollution can be important because of the area of land involved. This is especially true for activities like agriculture that use large areas of land. Because of the pervasiveness of agriculture in the Assiniboine River Watershed and the potential effects the industry can have on water quality, it is necessary to identify specific agricultural practices that can help reduce these risks, especially with respect to nutrient movement.

Other watershed activities can also contribute significant amounts of nutrients, sediment, and pathogens to surface waters. In order to ensure that all activities are identified and all reasonable key actions are taken, it is critical to consider all of the activities that contribute these pollutants within the watershed.

Concern about nutrient movement into water and the subsequent degradation of water quality continues to be a primary concern for lake managers. This is apparent in various studies that have been conducted on Lake of the Prairies, and also from concerns that have been expressed about the eutrophication of Lake Winnipeg. Special attention will therefore be paid in this plan to recommendations and key actions that address human activities which result in the movement of nutrients to water bodies.

Recommendations

4.1 Prepare a nutrient reduction plan to reduce nutrient loading within the watershed, with the following targets:

  a. a total phosphorus value of less than 0.24 mg/L for the Assiniboine River at the Prairie Provinces Water Board monitoring site near Kamsack.

  b. a total nitrogen value of less than 1.85 mg/L for the Assiniboine River at the Prairie Provinces Water Board monitoring site near Kamsack.

To calculate the above parameters, water quality data for the Assiniboine River near Kamsack from 1977 to 2003 was reviewed. The 90th percentile for both total phosphorous and total nitrogen was then determined, and these values were selected as the nutrient targets. The 90th percentile is a standard method reviewed in the protocols for determining site specific guidelines, as outlined by the Canadian Council of Ministers of the Environment.

It should be noted that these target values should be considered as notional targets or transitional values. The values will be reviewed and compared at a later date by the Prairie Provinces Water Board and/or Saskatchewan Environment and the Saskatchewan Watershed Authority as part of another process to establish provincial boundary surface water quality objectives at Prairie Provinces Water Board monitoring sites.

The Prairie Provinces Water Board monitoring site is a very comprehensive monitoring station. However, it is located at the bottom of the Assiniboine River Watershed and thus, although representative of the watershed, there is no information on the various subwatersheds or streams within the watershed. It would be of value to have an understanding of how the water quality (for this watershed, nutrients would be the major focus) differs across the watershed, from the upstream reaches to the lower end, as well as to determine if there are differences between the more major subwatersheds.

Balancing the need for sufficient data to understand the variability in water quality across the watershed with the costs of monitoring requires careful consideration. This balance must maximize the usefulness of additional monitoring stations while minimizing the costs. Additional monitoring in the watershed should be conducted in conjunction with a hydrometric station.

There are many benefits from reducing summer fallow (fallowed by tillage) and increasing direct seeding of cropped land. However, under these management practices weeds are primarily controlled by herbicides. Therefore it is critical to ensure the proper handling of herbicides (and all pesticides) and monitor their transport and fate to ensure that they do not impact negatively on water quality.

Key Actions

Every sector should contribute toward the nutrient reduction plan for the watershed. This is viewed as a collaborative initiative and does not assume or place blame on any particular sector.

For each sector the Committees developed key actions that they felt would have the greatest impact on nutrient reduction. It was recognized that the list of key actions would not necessarily be exhaustive, but would instead initially direct the implementation strategy toward key actions that would furthest reduce nutrient loading.

Within Objective 4, key actions were developed for each sector or risk area. The categorization of these actions by sector follows the process of not focussing on any particular sector, but rather expecting that each sector will contribute toward the nutrient reduction plan for the watershed.

4.1.1 Agriculture (non-point source)

There are two principal strategies for reducing phosphorous movement in the Assiniboine River Watershed. The first is to minimize soil erosion (wind or water). This is particularly important as the soil types present in the Assiniboine River Watershed readily bind phosphorus. The second strategy to manage water runoff is by encouraging "water harvesting" and maintaining water retention on upland locations.

Some forms of nitrogen are highly soluble, and thus very mobile. The key to reducing nitrogen loading is to adopt the practice of efficient water harvesting.

Water harvesting refers to the practice of using as much of the available water in the rooting zone as possible each year. Since water is the most important yield limiting factor in Saskatchewan dryland crop and forage production, this practice makes sound economic and environmental sense. A realistic yield potential should be based on available soil water and average growing season precipitation, and then applying nutrients near the time of crop use. Using as much of the available water from the rooting zone as possible to grow crops and forage greatly decreases the potential of water movement (both surface runoff and downward leaching) and associated nutrient movements.

Key Action: Encourage and work with producers to decrease the number of cultivated acres that are under summer fallow management (fallowed by tillage) in the Assiniboine River Watershed by 50 percent over the years 2006 to 2011.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Soil Conservation Association* Saskatchewan Agriculture and Food Assiniboine Advisory Board

This key action is based on matching provincial trends. Agriculture and Agri-Food Canada census data will be collected in both 2006 and 2011 and will be used for the evaluation.

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* Indicates the organization(s) responsible for leading the key action

Key Action: Encourage and work with producers to increase the number of cultivated acres that are direct seeded in the Assiniboine River Watershed (with the appropriate nutrient management) by 100 percent over the years 2006 to 2011.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Soil Conservation Association* Saskatchewan Agriculture and Food Assiniboine Advisory Board

This key action is also based on the provincial trend. Increasing direct seeded acres not only reduces erosion but also increases infiltration rates, thus reducing surface runoff.

Key Action: Encourage and work with producers to increase the number of kilometres of functional riparian buffers along cultivated fields and pasture lands that are adjacent to water courses.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Watershed Authority* Assiniboine Advisory Board* Saskatchewan Agriculture and Food Ducks Unlimited Canada Fisheries and Oceans Canada

Buffers not only trap sediments, they can also remove dissolved nitrogen before it reaches a watercourse.

Key Action: Encourage and work with producers to reduce the number of cultivated acres that are sensitive to wind and/or water erosion (because of the soil type and/or topography) by converting this land to permanent cover.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food* Saskatchewan Watershed Authority Ducks Unlimited Canada Prairie Farm Rehabilitation Administration Assiniboine Advisory Board

Key Action: Promote the retention and restoration of wetlands on the uplands through education and programming.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food Ducks Unlimited Canada Saskatchewan Watershed Authority Assiniboine Advisory Board

Wetlands and uplands in the watershed are important and should be protected. The continual removal and degradation of the uplands associated with wetlands and riparian areas will place the watershed health at risk.

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* Indicates the organization(s) responsible for leading the key action

Key Action: Collect water quality nutrient data at strategic points in the watershed to determine the variability of nutrients within the watershed.

Time Frame	Responsibility
2007 – 2008	Saskatchewan Watershed Authority Assiniboine Advisory Board

4.1.2 Livestock (all aspects)

Manure should be handled as a fertilizer, and not as a waste product. Manure should be applied to land at appropriate rates so that it is not a centralized risk and doesn't act as a point source for nutrients, pathogens or sediment. Another concern to source water protection may include ensuring that potential pathogens are prevented from entering ground or surface water sources. The Manure Application Rate Calculator (MARC) 2005 is a manure management planning software for Manitoba and Saskatchewan.

As cattle manure has a high phosphorous to nitrogen ratio, it is a potential risk for phosphorus accumulation in soils and increased transfer of phosphorus to surface water. Care must be exercised to base inputs on the amount of phosphorous required and not nitrogen in order to avoid applying excess phosphorous. Hog manure is more similar to commercial fertilizers (i.e. a better phosphorous to nitrogen ratio for crop uptake) and thus, depending on its application rate, poses less of a phosphorous accumulation risk. However, excess application and or repeated applications of any manure increases the potential for nutrient movement.

Key Action: Encourage all producers to develop and adopt manure management plans.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food Assiniboine Advisory Board

Key Action: Encourage and work with producers to eliminate the use of cattle concentration sites near waterways.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food* Saskatchewan Watershed Authority Environment Canada Assiniboine Advisory Board

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* Indicates the organization(s) responsible for leading the key action

Key Action: Encourage and work with producers to eliminate the prolonged occurrences of bank destabilization from livestock activities. The loss of vegetation removes the buffer barrier.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food* Saskatchewan Watershed Authority Environment Canada Assiniboine Advisory Board

Key Action: Develop a strategy to manage leased Crown lands so that livestock pastured on them have minimal impact on source water in the Assiniboine River Watershed.

Time Frame	Responsibility
2006 – 2011	Saskatchewan Agriculture and Food* Saskatchewan Watershed Authority Saskatchewan Environment

Water management issues arising on Crown lands that affect adjacent land owners need to be addressed.

4.1.3 Roadways

Roadways and ditches are prevalent throughout the Assiniboine River Watershed, frequently intersecting creeks, streams, and rivers.

Roadway drainage ditches may function as watercourses. They can act as a source of contaminants, and can act as a conduit for nutrients and contaminants from the adjoining uplands to join connecting waterways.

Beaver activities (more specifically, the water associated with their activities) on Crown lands may create problems with roadways. Rural municipalities have expressed the need for the Government of Saskatchewan to maintain programs similar to the channel clearing assistance program in order to control beavers and their activities.

Key Action: Enhance roadway construction practices by developing best practices to reduce the impact on adjacent water courses. For example, road ditches should be seeded as soon as possible after construction to minimize erosion.

Time Frame	Responsibility
2006 – 2007	Saskatchewan Highways and Transportation* Saskatchewan Association of Rural Municipalities Saskatchewan Urban Municipalities Association Fisheries and Oceans Canada

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* Indicates the organization(s) responsible for leading the key action

Key Action: Funding approval for road construction should be contingent on the fulfillment of conditions and specifications related to these best practices. Natural drainage patterns are to be maintained.

Time Frame	Responsibility
2008	Saskatchewan Highways and Transportation Saskatchewan Association of Rural Municipalities Saskatchewan Urban Municipalities Association Prairie Farm Rehabilitation Administration Federal Infrastructure

4.1.4 Urban Stormwater

There is little water quality information available on the stormwater from smaller cities and towns in the Canadian prairies. This information gap needs to be addressed.

Key Action: Proceed with the proposed City of Yorkton stormwater study by the Saskatchewan Watershed Authority and the City of Yorkton as soon as possible.

Time Frame	Responsibility
2006 – 2007	Saskatchewan Watershed Authority City of Yorkton

Key Action: Develop a guideline document detailing best practices for managing stormwater, emphasizing source water protection for the Province of Saskatchewan.

Time Frame	Responsibility
Completed	Saskatchewan Environment*

Key Action: Inform communities about these guidelines and encourage them to begin adopting the recommended best practices.

Time Frame	Responsibility
2006 and forward	Saskatchewan Environment Saskatchewan Urban Municipalities Association Assiniboine Advisory Board

4.1.5 Municipal Wastewater

Every community in the Assiniboine River Watershed (except the City of Yorkton) utilizes wastewater lagoons to treat their effluents. They are an economical standard practice for treating wastewater.

A review of the literature supports the effectiveness of treating domestic sewage by using two-cell lagoons. In fact, two-cell lagoons, if they are managed and operated as designed, can be as effective as highly technical tertiary wastewater treatment plants.

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* Indicates the organization(s) responsible for leading the key action

Even though communities are following the lagoon operation guidelines as determined by Saskatchewan Environment, landowners located downstream of the lagoons have expressed concerns about the effect of lagoon releases on water quality.

According to the document *Optimization of Lagoon Operation: A Best Practice* (prepared by the National Research Council - National Guide to Sustainable Municipal Infrastructure) there are several opportunities to improve the water quality of effluent releases. Residents in the watershed want the Government of Saskatchewan to consider this document as part of the Province's review of lagoons in the Assiniboine River Watershed.

Key Action: Provide a risk rating of all municipal wastewater lagoons within the watershed.

Time Frame	Responsibility
2006	Saskatchewan Environment*

Key Action: Determine the total lagoon nutrient releases within the watershed and estimate the significance of this from a nutrient balance perspective.

Time Frame	Responsibility
2006 – 2007	Saskatchewan Environment Saskatchewan Watershed Authority

Key Action: Evaluate the current lagoon release regulations to determine if they are appropriate based on the estimated significance of the total nutrient load of the lagoons, and then determine if changes in lagoon practices are warranted.

Time Frame	Responsibility
2008	Saskatchewan Environment Saskatchewan Watershed Authority

Key Action: Inform landowners and communities downstream of lagoons of pending releases in order to synchronize surface water withdrawals and usages with the releases.

Time Frame	Responsibility
2007 – 2008	Saskatchewan Environment Saskatchewan Urban Municipalities Association Saskatchewan Association of Rural Municipalities Assiniboine Advisory Board

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* Indicates the organization(s) responsible for leading the key action

4.1.6 City of Yorkton Wastewater

The City of Yorkton's wastewater treatment plant is a major point source of nutrients in the Assiniboine River Watershed. It is the only mechanical treatment facility in the Assiniboine River Watershed. The treated effluent is continually discharged to Yorkton Creek throughout the year. The City is regulated by the Government of Saskatchewan and operates the plant according to provincial guidelines.

Key Action: Determine the information gap regarding the 'environmental fate' of the wastewater plant nutrient releases to Yorkton Creek and the Whitesand River.

Time Frame	Responsibility
2007 – 2010	Saskatchewan Watershed Authority* Saskatchewan Environment City of Yorkton

Key Action: Evaluate the plant to determine if there are relatively simple and inexpensive modifications that can be made to the plant and/or to its operations that would reduce the amount of nutrients in the plant effluent. This optimization review may qualify for funding.

Time Frame	Responsibility
2007 – 2008	Saskatchewan Environment City of Yorkton Saskatchewan Watershed Authority

Key Action: Conduct a basic nutrient source analysis for the City of Yorkton to determine if there are opportunities to reduce nutrient loading prior to waste reaching the treatment plant.

Time Frame	Responsibility
2006	Saskatchewan Watershed Authority* City of Yorkton

Key Action: Develop an education strategy for the community to enhance residents' awareness of their impact on the City's wastewater.

Time Frame	Responsibility
2007	Saskatchewan Watershed Authority* City of Yorkton Assiniboine Advisory Board

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* Indicates the organization(s) responsible for leading the key action

Objective 5:
Develop education strategies and increase awareness of source waters and their associated issues within the Assiniboine River Watershed.

Introduction

Increasing the education and awareness of residents about their watershed and related watershed issues requires a specific emphasis, which is best served by having a separate objective. However, it should be noted that education and awareness are also important components of every objective, recommendation and key action contained in this plan.

Residents of the watershed should know the importance of, and the issues surrounding, source water protection. The residents of the watershed all share in the use of the watershed's resources, and should appreciate that the quality of source water can be negatively affected by their activities.

Saskatchewan Environment is the principal regulator of municipal waterworks and all privately owned and publicly accessible waterworks that have flow rates of 18,000 litres or more per day. Saskatchewan Environment also regulates certain pipeline systems. The owners of urban potable water systems are required to take regular samples of the water in order to test for basic biological and chemical constituents, use certified operators, and are far more regulated than owners of rural systems.

Ensuring the health and safety of rural populations also requires source water sampling and analysis. A water quality monitoring strategy for rural residents will assist in increasing the awareness of source water protection and will provide water quality data on various aquifers and surface water sources.

Recommendation

5.1 Institute a rural source water protection campaign.

Key Action: Communicate the Saskatchewan Watershed Authority's definition of source water protection to residents within the Assiniboine River Watershed.

Time Frame	Responsibility
2007 and onwards	Saskatchewan Watershed Authority* Assiniboine Advisory Board

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* Indicates the organization(s) responsible for leading the key action

Recommendation

5.2 Ensure the rural population conducts regular sampling of their source water.

Key Action: Promote the importance of regular water quality testing.

Time Frame	Responsibility
2007 onwards	Sunrise Health Region Saskatchewan Association of Rural Municipalities Saskatchewan Watershed Authority Assiniboine Advisory Board

Key Action: Deliver regular water quality testing campaigns.

Time Frame	Responsibility
2007 onwards	Sunrise Health Region Saskatchewan Association of Rural Municipalities Saskatchewan Watershed Authority Saskatchewan Research Council Assiniboine Advisory Board

Recommendation

5.3 Promote the importance of participation in the Environmental Farm Plan (EFP) program.

Key Action: Encourage producers to participate in completing the Environmental Farm Plan workbook.

Time Frame	Responsibility
2006 – 2007	Provincial Council of Agriculture Development and Diversification Boards* Saskatchewan Watershed Authority Saskatchewan Agriculture and Food Ducks Unlimited Canada Assiniboine Advisory Board

The Provincial Council of Agriculture Development and Diversification Boards (PCAB) deliver the Environmental Farm Plan program in Saskatchewan. PCAB is a producer-driven, grass-roots organization that is based on the Rural Municipality system within the province. Information provided by the participating producers is voluntary and confidential.

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* Indicates the organization(s) responsible for leading the key action

Key Action: Encourage the Provincial Council of Agriculture Development and Diversification Boards and producers to work together to identify common "on-farm" environmental issues.

Time Frame	Responsibility
2006 – 2007	Saskatchewan Watershed Authority Saskatchewan Agriculture and Food Saskatchewan Environment Environment Canada

Key Action: Select programs to address these issues.

Time Frame	Responsibility
2006 – 2007	Saskatchewan Watershed Authority Saskatchewan Agriculture and Food Ducks Unlimited Canada

Recommendation

5.4 Saskatchewan Agriculture and Food needs to be more involved in the education component. There is a benefit to using a stewardship-type model in providing education.

Recommendation

5.5 Promote the importance of a regular soil testing program throughout the watershed. Provincially, less than 20 percent of all fields are soil tested annually.

6. New and Emerging Issues

An aim of the Assiniboine River Watershed Source Water Protection Plan is to identify activities that pose the greatest risk to the quality and quantity of source water in the watershed and work toward mitigating those risks. There are several issues that were not directly addressed in the risk analysis, in part because the issues have not been well studied within the watershed, and/or in part because they are new so it was difficult to assess their relevance and/or importance. However, these issues require further consideration as our understanding of them increases. One of the vital characteristics of a formal Assiniboine Advisory Board, with a Local Watershed Manager, is that it will have the ability to address, as appropriate, these new and emerging issues and thereby maintain the flexibility needed to provide source water protection in the watershed.

Two emerging issues identified at this time which may be important but require further study/consideration are: 1) the effects of pesticides in the environment; and 2) the presence and effects of pharmaceuticals in the environment.

Pesticides

Pesticides have been found throughout the environment, though typically at low concentrations which are below the Saskatchewan Surface Water Quality Objectives and Saskatchewan's Drinking Water Quality Standards and Objectives. Many of the pesticides found in regions of Saskatchewan are not locally applied, demonstrating the importance of aerial drift and the long-range transport of pesticides. However, many of the pesticides applied in Saskatchewan do end up in source waters. For example, a study found that more than 10 percent of the wetlands examined had at least one pesticide present during the year at concentrations greater than the Canadian Water Quality Guidelines. Increased pesticide use within the watershed is an implied consequence as farms move toward the implementation of minimum-till or no-till practices. Previous mention has been made of the benefits of minimum-till practices; however, it is important to pay close attention to any threats to water quality that occur as a consequence of this practice to ensure a healthy balance is maintained.

There is on-going research with respect to best management techniques to minimize the application losses of pesticides (National Agri-Environmental Standards Initiative – NAESI), the cumulative effects of pesticides (Environment Canada) and the fate and transport of pesticides in dugouts and wetlands (Prairie Farm Rehabilitation Administration).

Pharmaceuticals, Personal Care Products, Hormones and Hormone-like Substances

Understanding the distribution, concentration and environmental effect of pharmaceuticals is an emerging issue in environmental science and management. The scale and significance of this issue, as related to source water protection, is currently unknown. While studies have documented the presence of pharmaceuticals in both waste effluent, effluent mixing zones, surface water and drinking water (at the tap), there are fewer studies that have looked at this large range of compounds to assess their effect on aquatic ecosystem and human health. Pharmaceuticals, care products, and hormone-like substances can arise from many sources and can persist in the environment in various forms. However, human and agricultural animal waste is a principal source. Compounds tend to break down more readily during summer months when conditions are warmer, sunlight is more intense (photodegradation) and microbes are more active. Apart from points of discharge (i.e. mixing zones) these compounds will be found at low concentrations when there is sufficient dilution.

Two areas of potential interest within the Assiniboine River Watershed are wastewater treatment plants/lagoons and from livestock operations.

The prairies are somewhat unique in the design and function of sewage lagoons because sewage release is typically only needed once or twice a year. This means that the products entering these lagoons have an increased chance of being removed prior to entering the environment, either through bacterial degradation, photodegradation or sorption onto particles or sediment. The effectiveness of these sewage lagoons compared to mechanized treatment facilities is unknown at this time; however, studies have demonstrated that lagoons can be effective in the removal of certain compounds.

Environment Canada conducted a preliminary study looking for various compounds in the Assiniboine River at the Kamsack Prairie Provinces Water Board station in 2002 and 2003. Several compounds were detected, but at low concentrations. The low concentrations are in part due to the dilution effect, especially during spring.

The following table summarizes the information on the compounds detected in river water at the Prairie Provinces Water Board site near Kamsack. It should be noted that several other compounds analyzed were not detected, including: ibuprofen, acetaminophen, gemfibrozil, fenoprofen, fenofibrate, ketaprofen, and indomethacin.

Compound	**Concentration(µg/L)**		
	March 2003	June 2002	March 2002
Clofibric acid (Heart medication)	0.00199	0.00177	0.00114
Salicylic acid (Aspirin by-product, also in personal care products)	0.00360	0.00095	0.00159
Naproxen (Anti-inflammatory)	0.00302	0.00085	0.00099
Triclosan (Broad-spectrum antibacterial/ antimicrobial agent)	0.00033	0.00024	0.00061
Diclofenac (Anti-inflammatory)	0.00146	not detected	not detected

Table 8: Compounds detected at Prairie Provinces Water Board site near Kamsack

The extent and potential consequences of the presence of these compounds within the Assiniboine River Watershed are currently unknown, and this is best identified as an information gap. However, because of their importance it is necessary to consider them and be aware of changes in practices that could affect their distribution.

To fill this information gap it is recommended that a study be conducted to examine the efficacy of sewage lagoons in breaking down and removing pharmaceuticals, personal care product derivatives, and hormones and hormone-like compounds. Previous studies have demonstrated that greater breakdown of these compounds occurs during summer. It is therefore anticipated that there may be a build up of compounds during winter, whereas during summer lagoons will be more efficient at breaking down these products. Concentrations in the river will also depend on dilution, which is higher in the spring. Until a study is conducted that specifically examines the ability of prairie lagoons to process these products, the scope of this issue will not be fully understood.

Livestock operations are also a potential environmental source of antimicrobial compounds and hormones. There are currently studies underway on the prairies examining the degradation efficiency, environmental persistence and environmental fate of common antimicrobial compounds added to hog and cattle feed. Preliminary results suggest that antimicrobial compounds from livestock operations can be found in both surface and groundwater at relevant concentrations. The environmental impact of these compounds is still not widely known. The recent initiation of a study examining the impact of antibiotics in prairie wetlands will help to address this question. This emerging issue requires further consideration as more studies are conducted and study results become available. Re-examination of recommendations about the handling of manure will need to be considered in the context of this information.

7. Glossary

Aerobic – living or taking place only in the presence of oxygen.
Allocation – the amount of water assigned for use, out of the total amount that is available for use in a particular watershed or aquifer.
Anaerobic – living or taking place in the absence of oxygen.
Aquatic – consisting of, relating to or being in water; living or growing in, on or near water.
Aquifer – a permeable body of rock capable of yielding usable quantities of groundwater to wells and springs.

Base of groundwater exploration – a feature shown on the provincial groundwater maps. Defines the depth to which it is generally considered to be uneconomic to explore for groundwater because of the depth of drilling required and/or the water at that depth is considered to be too highly mineralized for the intended use.
Bedrock formations – rock deposited prior to glaciation. These layers are overlain by glacial deposits which consist of glacial till, sand and gravel.
Biodiversity (biological diversity) – the many and varied species of life forms on earth, including plants, animals, micro-organisms, the genes they possess and their habitats.

Climate – meteorological elements (e.g. precipitation, temperature, radiation, wind, cloudiness) that characterize the average and extreme conditions of the atmosphere over long periods of time at a location or region of the earth's surface.
Climate change – an alteration in measured meteorological conditions that significantly differs from previous conditions and is seen to endure, bringing about corresponding changes in ecosystems and socio-economic activities.
Conservation – the preservation and renewal, when possible, of human and natural resources. The use, protection and improvement of natural resources according to principles that ensure their highest economic and social benefits.
Conservation easement – a voluntary legal agreement between a property owner and a government or qualified conservation agency. These agreements are tailored to each individual landowner and conserve the property's natural values and features by restricting the type and amount of development that can occur on the owner's property.

Development – building, engineering, mining or other operations that alter or intensify the use of a resource.
Deleterious substance – any substance that is deleterious to fish, fish habitat, or to the use by man of fish that frequent that water. See *The Fisheries Act* for further details.
Discharge – the flow of surface water in a stream or ditch or the flow of groundwater from a spring or flowing artesian well; the rate of flow.
Diversion – the removal of water from any waterbody, watercourse or aquifer (either for use or storage), including the removal of water for drainage purposes. Construction of any works required for the diversion of water need approval pursuant to Section 50 of *The Saskatchewan Watershed Authority Act*. The total diversion is equal to the allocation plus any losses from evaporation or seepage.
Drainage – movement of water off land, either naturally or man-made.
Drought – generally in reference to periods of less than average or normal precipitation over a set time, sufficiently prolonged to cause serious hydrological imbalance that results in biological or economic losses.

DUC – Ducks Unlimited Canada, an entity that conserves, restores and manages wetlands and associated habitat for North American waterfowl. These habitats also benefit other wildlife and people.

Ecological – pertains to the relationship between living organisms and their environments.
Economic development – the process of using and converting resources into wealth, jobs and an enhanced quality of life.
Ecosystem – a dynamic complex of organisms (biota) including humans, and their physical environment, that interacts as a functional unit in nature.
Effective drainage area – the area which is estimated to contribute runoff in at least half of the years.
Effluent – the treated wastewater discharged into the environment.

Facultative – bacteria that can live in a range of external conditions, including both aerobic and anaerobic conditions.
First Nation – an Indian band or an Indian community functioning as a band but not having official band status, not including Inuit or Métis peoples.

Grazing management – activities that ensure stocking rates are appropriate to sustain long-term health of livestock grazing conditions during wet and dry seasons.
Gross drainage area – the area bounded by the height of land between adjacent watersheds.
Groundwater – water beneath the surface of the earth in the pores and fractures of sand, gravel, and rock formations.

Habitat – natural surroundings or native environment where a plant or animal grows and lives.
Headwater – small streams and lakes that are the sources of a river, located in the upper reaches of a watershed.
Hydro – from the Greek hydor, meaning "water."
Hydrogeology – the science of subsurface waters and related geologic aspects.
Hydrology – the science of the waters of the earth, their occurrences, circulation and distribution on or below the earth's surface.

Intensive Livestock Operation (ILO) – production facilities such as feedlots and buildings where many animals are raised in a confined space that does not have naturally-growing vegetation and where waste accumulates if not removed (as defined by *The Agricultural Operations Act* in Saskatchewan).

Land cover – predominant vegetation on the surface of a parcel of land.
Land use – present use of a given area of land.
Leachate – a liquid that has percolated through or out of another substance such as soil or refuse, and may contain nutrients or contaminants.
Lithology – the characteristics of rock formations.

Median – a value in a sorted range of values by which there is the same number of values above it as there is below it. A statistical term used in non-parametric statistics.

Native prairie – age-old plant communities of the prairie and parkland regions that may contain more than 200 types of grasses, flowers and shrubs (native grassland and parkland aquatic and terrestrial habitats).

Non-point source pollution – single or multiple contaminants of unknown origin that enter waterways, degrading water quality.

Partnership – co-operative, collaborative alliance between/among stakeholders in a non-legal arrangement used to improve and build relationships and achieve common goals.

Permeability – the ability of a material to allow the passage of a liquid, such as water through rocks. Permeable materials, such as gravel and sand, allow water to move quickly through them, whereas impermeable material, such as clay, does not allow water to flow freely.

Point source contamination – a static and easily identifiable source of air, soil or water pollution.

Recharge – replenishment of the groundwater by the addition of water.

Riparian – an area of land adjacent to or connected with a stream, river, lake or wetland that contains vegetation that is distinctly different from vegetation of adjacent upland areas.

Riparian areas – the zone of vegetation alongside waterways and other surface water. Lush and diverse vegetation is the best sign of healthy, well-managed riparian areas and is critical to filtering and slowing runoff.

River basin – an area that contributes to form a watershed.

Sewage – the waste and wastewater from residential or commercial establishments that are normally discharged into sewers.

Sewage lagoon – a shallow pond where sunlight, bacterial action and oxygen work to purify wastewater; also used for storage of wastewater.

Source water protection – the prevention of pollution and the sound management of factors and activities that (may) threaten water quality and quantity of lakes, reservoirs, rivers, streams and groundwater.

Stakeholder – individual or group with direct or indirect interest in issues or situations, usually involved in understanding and helping resolve or improve their situations.

Stewardship – judicious care and responsibility by individuals or institutions for reducing their impacts on the natural environment.

Water quality – the chemical, physical and biological characteristics of water with respect to its suitability for a specific use.

Watershed – an elevated boundary contained by its drainage divide and subject to surface and subsurface drainage under gravity to the ocean or interior lakes.

Watershed health – the desired maintenance over time of biological diversity, biotic integrity and ecological processes of a watershed.

Watershed and aquifer management – a process, within the geographic confines of a watershed or aquifer, that facilitates planning, directing, monitoring and evaluating activities to ensure sustainable, reliable, safe and clean water supplies.

Watershed and aquifer planning – a process, within the geographic confines of a watershed or aquifer and with the participation of stakeholders, to develop plans to manage and protect water resources.

Wetland – an area of low-lying land covered by water often enough to support aquatic plants and wildlife for part of the life cycle. The wetland area includes the wet basin and adjacent upland.

8. Glossary of Units

Length

1.0 m = 1.0 metre
= 3.28 feet
= 39.37 inches

1.0 km = 1.0 kilometre
= 1,000 metre
= 0.621 miles

Area

1.0 m^2 = 1.0 square metre
= 10.76 square feet

1.0 km^2 = 1.0 square kilometre
= 1.0 X 10^6 square metres
= 0.386 square miles
= 247 acres
= 100 hectares

Volume

1.0 m^3 = 1.0 cubic metre
= 35.31 cubic feet
= 220.083 imperial gallons
= 1,000 litres

1.0 dam^3 = 1.0 cubic decametre
= 1000 cubic metres
= 220,083 imperial gallons
= 0.810 acre feet

1.0 ig = 1.0 imperial gallon
= 4.54 litres
= 0.00454 cubic metres
= 0.1605 cubic feet

1.0 l = 1.0 litre
= 0.221 imperial gallons
= 0.264 US gallons
= 0.001 cubic metres
= 0.035 cubic feet

Rate

1.0 igpm = 1.0 imperial gallon per minute
= 0.833 US gallons per minute
= 0.076 litres per second
= 6.54 m^3/day
= 1.94 acre feet/year
= 2.39 dam^3/year

1.0 lps = 1.0 litres per second
= 13.22 imperial gallons per minute
= 11.01 US gallons per minute
= 8.640 m^3/day
= 31.54 dam^3/year

1.0 m^3/day = 1.0 cubic metres per day
= 220 imperial gallons per day
= 0.0116 litres per second
= 35.32 cubic feet per day

1.0 dam^3/day = 1.0 cubic decametres per day
= 1,000 cubic metres per day
= 35,320 cubic feet per day

Table based on Beckie Hydrogeologists (1990) Ltd.

9. Appendices

A. **Watershed Advisory Committee Members**

B. **Technical Committee Members**

C. **Fish Species of the Upper Assiniboine River Basin**

D. **Water Quality and Water Quality Trends for the Assiniboine River at Kamsack (on CD)**

E. **Assiniboine River Watershed Issues Analysis (on CD)**

F. **Assiniboine River Watershed Background Report (on CD)**

A. Watershed Advisory Committee Members

Assiniboine River Watershed Advisory Committee

Member	Representing
Brian Bolouc/ Denis Wishnevetski	Town of Kamsack
Vern Bowes	Rural Municipality of Cote No. 271
Wallace Butterfield	Rural Municipality of Keys No. 303
Gil Comeault	Rural Municipality of St. Philips No. 301
Douglas Ferder	Rural Municipality of Clayton No. 333
Don Fogg	Town of Langenburg
Terry Keewatin	Yorkton Tribal Council/Cote First Nation
Neil Mehrer	Rural Municipality of Churchbridge No. 211
Ken Mitchell	Rural Municipality of Preeceville No. 334
Don Olson (Chair)	Town of Sturgis
Ernie Patrick	Sask Pork
Marlo Schappert	Rural Municipality of Langenburg No. 181
Gerald Schepp	Rural Municipality of Calder No. 241
Beatrice Sekel	Town of Preeceville
Ken Somogyi	Saskatchewan Wildlife Federation

Whitesand River Watershed Advisory Committee

Member	Representing
Russel Baron	Buchanan Conservation & Development Area
Viola Bell	Metis Nation of Saskatchewan
Shirley Biro	Village of Willowbrook
Dale Cherry/ Gary Liebrecht	Rural Municipality of Wallace No. 243
Fay Hanson	Rural Municipality of Foam Lake No. 276
Dale Heshka	City of Melville
Janet Hill	City of Yorkton
Jeff Hunter	Village of Rama
James Hupka	Rural Municipality of Good Lake No. 274/ Burgiss Conservation & Development Area
Ed Keyowski	Rural Municipality of Sliding Hills No. 273
Adam Kosar	Village of Buchanan
Ron Kulyk	Rural Municipality of Sasman No. 336
Garry Kupchinski	Rural Municipality of Buchanan No. 304
Ben Pengilly	Rural Municipality of Cana No. 214
Bob Pratt	Fishing Lake First Nation/ Touchwood Agency Tribal Council
Jack Prychak/ Tom Niecker	Rural Municipality of Invermay No. 305
Ray Reisz	Friends of Good Spirit Lake
Al Schatz	Rural Municipality of Stanley No. 215
Eugene Secondiak	Good Lake Conservation & Development Area
Ken Smuk	Rural Municipality of Garry No. 245
Don Taylor	Rural Municipality of Saltcoats No. 213
Don Walters	Spirit Creek Monitoring Group

B. Technical Committee Members

Member	Representing
Brad Ashdown	Saskatchewan Watershed Authority
Doug Brook	Ducks Unlimited Canada
Mike Buchholzer	City of Yorkton
Brian Campbell	Saskatchewan Agriculture and Food
Tim Cheesman	Saskatchewan Government Relations
John-Mark Davies	Saskatchewan Watershed Authority
John Fahlman	Saskatchewan Watershed Authority
Jon Gaudrey	Sunrise Health District
Ross Herrington	Environment Canada
Rob Kirkness	Saskatchewan Watershed Authority
Neil Lamberty	Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration
Darlene McLeod	Saskatchewan Health
Rick Orr	Fisheries and Oceans Canada
Jason Puckett	Saskatchewan Watershed Authority
Jim Rodgers	Environment Canada
Warren Thomson	Saskatchewan Watershed Authority
Rob Walcer	Saskatchewan Watershed Authority
Joe Zarowny	Saskatchewan Environment

C. Fish Species of the Upper Assiniboine River Basin

Scientific Name	Common Name	Abbreviation
Ambloplites rupestris	rock bass	RCBS
Ameiuris nebulosis	brown bullhead	BRBL
Catostomus commersoni	white sucker	WHSC
Carpiodes cyprinus	quillback	QUIL
Culaea inconstans	brook stickleback	BRST
Cyprinus carpio	common carp	CMCR
Esox lucius	northern pike	NRPK
Etheostoma exile	Iowa darter	IWDR
Etheostoma nigrum	johnny darter	JHDR
Hiodon tergisus	mooneye	MOON
Hybognathus hankinsoni	brassy minnow	BRMN
Ichthyomyzon castaneus	chestnut lamprey	CHLM
Lota lota	burbot	BURB
Luxilus cornutus	common shiner	CMSH
Margariscus margarita	pearl dace	PRDC
Moxostoma anisurum	silver redhorse	SLRD
Moxostoma macrolepidotum	shorthead redhorse	SHRD
Notropis atherinoides	emerald shiner	EMSH
Notropis dorsalis	bigmouth shiner	BGSH
Notropis heterolepis	blacknose shiner	BLSH
Notropis hudsonius	spottail shiner	SPSH
Notropis stramineus	sand shiner	SNSH
Noturus flavus	stonecat	STON
Perca flavescens	yellow perch	YLPR
Percina maculata	blackside darter	BLDR
Percopsis omiscomaycus	trout-perch	TRPR
Pimephales promelas	fathead minnow	FTMN
Pungitius pungitius	ninespine stickleback	NNST
Rhinichthys atratulus	blacknose dace	BLDC
Rhinichthys cataractae	longnose dace	LNDC
Semotilus atromaculatus	creek chub	CRCH
Stizestedion vitreum	walleye	WALL

Data sources:
McCulloch, B.R. and W.G. Franzin. 1996. *Fishes of the Canadian portion of the Assiniboine River drainage.* Can. Tech. Rep. Fish . Aquat. Sci. 2087:v + 62 p
Sentar Consultants Ltd. 1996. *Inventory of fish occurrences and morphological characteristics of streams in the Assiniboine River drainage basin in Saskatchewan.* Prepared for Dept. Fisheries and Oceans Canada.
SERM file information

(Note: Only native species and introduced species that have established self-sustaining populations are listed. Exotic species that rely on stocking to maintain a population are not included).

10. References

Saskatchewan Bureau of Statistics. 2003 Economic Review, number fifty seven. Government of Saskatchewan. Canada.

Fung, Ka-iu. 1999. *Atlas of Saskatchewan*. University of Saskatchewan. Saskatoon Saskatchewan.

Saskatchewan Environment. 2004. *Two Cell Lagoon Operation and Maintainence*, EPB 310.

SaskWater. 1997. *Assiniboine River Basin Overview.*

SaskWater. 2000. *Upper Assiniboine River Basin Study.*

Saskatchewan Watershed Authority. 2005. *Preliminary Background Report Moose Jaw River Watershed.*

Water Quality and Water Quality Trends for the Assiniboine River at Kamsack

Summary

Water quality on the Assiniboine River at Kamsack, as evaluated by the Water Quality Index, was deemed to be of consistently fair to good quality between 1989 and 2004. The water quality index (WQI) objectives most often exceeded were total phosphorus, total dissolved solids (TDS), and to a lesser extent dissolved oxygen. A pronounced seasonality was observed for many parameters. For example, TDS typically exceeded water quality objectives during winter months, but rarely during spring runoff. Of the occasions when dissolved oxygen did not meet its water quality objective, the greatest proportion of these occurred during winter months. However, on several occasions dissolved oxygen was found not to meet its objective during the middle of summer.

Concentrations of dissolved inorganic nitrogen and total dissolved phosphorus were high, suggesting plankton were not nutrient limited. This conclusion of non-nutrient limiting conditions of the plankton community is similar to that made by Fortin and Gurney (1997) in their study of Lake of the Prairies. Nutrient concerns in rivers often focus on periphyton and macrophyte communities as opposed to plankton communities; however, there are no known data on the Assiniboine River system with which to evaluate nutrient-periphyton/macrophyte relationships.

Introduction

The Upper Assiniboine River basin is approximately 21 000 km^2. The headwaters of the Upper Assiniboine River are northwest of Preeceville in the Porcupine Hills, approximately 150 km northwest of its inlet to Lake of the Prairies. The major Saskatchewan tributary is the Whitesand River, which joins the Assiniboine River at Kamsack. The Assiniboine River eventually joins the Red River in Winnipeg, flows into Lake Winnipeg, and joins the Nelson River system that drains into Hudson Bay. A significant portion of the Upper Assiniboine River land catchment is agricultural.

This report summarizes water quality and water quality trends at a single sampling site (Kamsack) on the Assiniboine River. Water quality was evaluated with the Water Quality Index (WQI). Key water quality parameters were also evaluated for trends.

Methods

Site:

Water quality parameters evaluated in this report were sampled and analyzed by the Prairie Provinces Water Board (PPWB) near Kamsack SK (Station Number: SA05MD0002, 51°31'59" N 101°53'20" W). The sampling site is located at the bridge on highway 8, approximately 2 km south of Kamsack. During summer samples are collected from the downstream side of bridge, in winter samples are collected approximately 20 m upstream of the bridge (water depth is greater). The earliest available data was from 1968, although routine monthly sampling did not occur until around 1974. Due to possible changes in laboratory procedures and the number of parameters measured, the water quality index was evaluated from 1989-2004. Trend analyses were also evaluated from 1989-2004, because it is less likely that significant monotonic trends will be detected in longer data sets.

Daily hydrometric flow data was obtained from the Water Survey of Canada (2005), Station ID: 05MD004 51°33'53" N 101°54'58" W.

Water Quality Index

The WQI was used to assess the overall water quality at Kamsack on the Assiniboine River. When available, up to seventeen water quality parameters were included in the index. For each parameter the objective established by Saskatchewan Environment and the Saskatchewan Watershed Authority was used as the basis for assessing overall water quality (Appendix 1).

On each sampling date, the WQI evaluates the value of each water quality parameter relative to its objective value. The index is calculated by assessing 1) "Scope", the number of parameters that exceed their objective at least once in a year, 2) "Frequency", the number of times a parameter exceeds its objective in a year, and 3) "Amplitude", the amount by which the objective value is exceeded.

WQI values range from 100 (excellent) to 0 (very poor). WQI scores were grouped into one of five categories that serve to summarize the overall state of water quality. The categories and category descriptions are as follows:

> **Excellent:** (WQI value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.
>
> **Good:** (WQI value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
>
> **Fair:** (WQI value 60-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
>
> **Marginal:** (WQI value 45-59) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
>
> **Poor:** (WQI value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

At least five different sampling dates per year were used to calculate the WQI for that year, with most years having 12 dates (monthly sampling).

The WQI calculator used was obtained from the Canadian Council of Ministers of the Environment (CCME 2005) and modified based on water quality parameters and their objectives set by Saskatchewan Environment and the Saskatchewan Watershed Authority (Appendix 1).

Trend Analysis

Nonparametric Mann-Kendall or Seasonal Kendall analyses were used to assess whether there were statistically significant increasing or decreasing trends in water quality parameters over time. Trend analyses were conducted using the computer program WQStat Plus (V.1.56).

Results

Flow

River flow characteristics are closely linked with water quality and river habitats. The Assiniboine is a perennial flashy river (Poff 1996) and is variable both within and among years. There were no apparent long-term increasing or decreasing trends in flow, although flow increased for several years in the mid 1990's (Figure 1a). Although the timing of the spring runoff peak is fairly consistent, its magnitude, and the magnitude of annual wintertime flow and late summer/early autumn low flow periods is variable among years (Figure 1b).

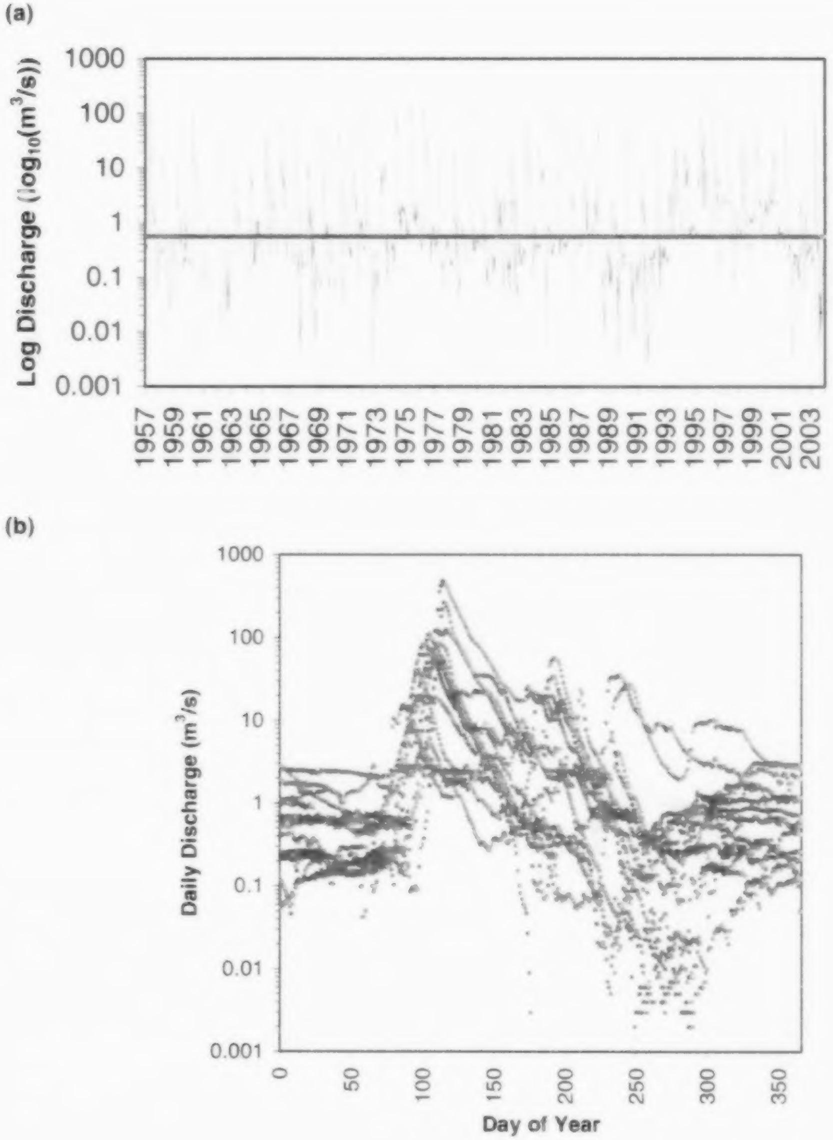


Figure 1: Average daily discharge on the Assiniboine River at Kamsack; (a) trends from 1957 to 2003, and (b) discharge for each day of the year between 1989 and 2003. Note log scales in (a) and (b). The horizontal line in (a) is the median discharge (0.56 m^3/s) from 1957 to 2003 (mean annual discharge = 5.68 m^3/s). Although there is an annual pattern in discharge, for example with a peak around April (approx. day of year 90–120), there is considerable variation in absolute discharge, discharge at high and low flow periods and the timing of secondary/tertiary peak flows. The maximum recorded discharge from 1957 to 2003 was 484 m^3/s in 1995.

Water Quality Index

The Assiniboine River at Kamsack is generally classified as having 'Good' to 'Fair' water quality (Figure 2). Total phosphorus often exceeded its objective, total dissolved solids (TDS) frequently exceeded its objective, and oxygen sometimes did not meet its objective. Other parameters either met or infrequently exceeded their objective.

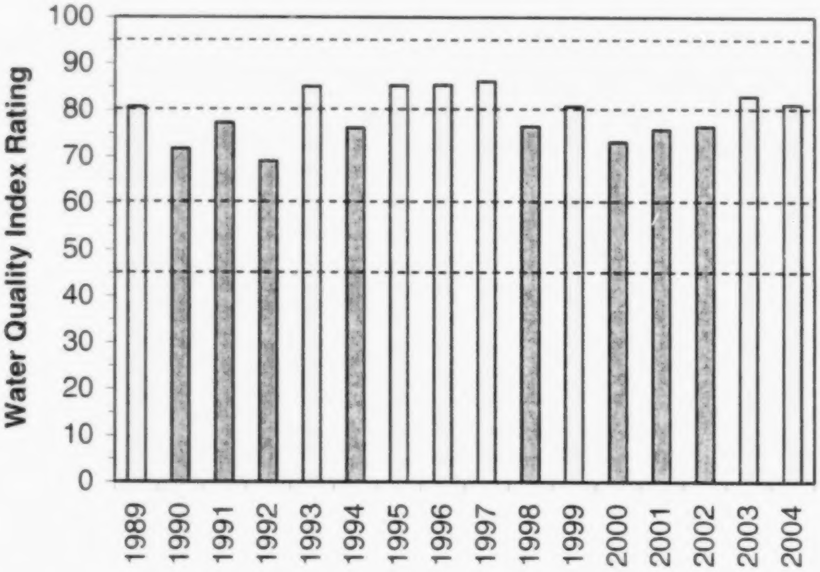


Figure 2: Water quality index rating for watershed protection at Kamsack on the Assiniboine River. Dashed lines correspond to WQI ratings (95-100 = 'Excellent', 80-95 = 'good', 60-80 = 'fair', 45-60 = 'marginal', less than 45 = poor.

Trend Analysis

Only pH, which increased, demonstrated a significant trend between 1989 and 2004 (Table 1). The measured maximum pH did not appear to increase between 1989 and 2004. However, the lowest measured pH seemed to increase. This increase in the lowest measured pH may be responsible for the significant increase in pH between 1989 and 2004 (Appendix 2-9). Trend analysis suggests a significant decrease in both 2,4-D and MCPA; however, a decrease in the detection limit over the period of study is responsible for this apparent trend (Appendix 2-11 and Appendix 2-12).

Table 1: Summary of trends for twelve water quality parameters at Kamsack on the Assiniboine River (1989 – 2003). Significant decreasing trends (↓), significant increasing trends (↑), and no significant trend (ns). No results are reported for 2,4-D and MCPA because of insufficient data, and/or too many values below the method detection limit.

	Kamsack
Dissolved Chloride (Cl^-)	ns
Dissolved Sodium (Na^+)	ns
Sulphate	ns
Total Dissolved Solids	ns
Total Phosphorus	ns
Nitrate/Nitrite	ns
Ammonia/Ammonium	ns
Dissolved Oxygen	ns
pH	↑
2,4-D	*
MCPA	*
Fecal coliforms	ns

* 2,4-D and MCPA measurements were often reported at the detection limit; however, the detection limit changed over time. Although the trend analyses suggest significant decreasing trends, these apparent trends are confounded by the change in detection limits.

Seasonal Cycles

There is an annual pattern in several water quality parameters, notably nutrients, alkalinity, conductivity, total dissolved solids, and turbidity (Appendix 3). Total nitrogen concentrations were typically greatest prior to, and during the beginning of spring runoff, whereas the greatest total phosphorus concentrations were observed either approximately a month prior to peak spring runoff, or around November (Appendix 3-1). Like total nitrogen, average nitrate and ammonia concentrations were greater during winter and early spring. The annual pattern in concentrations of total dissolved phosphorus is not distinct; however, peak concentrations more frequently occurred in the spring, summer and autumn (Appendix 3-2).

Measures of alkalinity, conductivity and total dissolved solids (TDS) all demonstrated a strong annual pattern (Appendix 3-3). All of these parameters were greatest during late autumn to late winter, they reached minimum values during spring run-off, and slowly increased during the summer. TDS is one of the parameters in the water quality index, so during winter months TDS is more likely to exceed its guideline (Appendix 3-3c). Turbidity, unlike alkalinity, conductivity and TDS, was greatest during spring run-off (Appendix 3-3d).

References

CCME (Canadian Council of Ministers of the Environment) 2005. Water, Water Quality Index, Index Calculator (Excel). http://www.ccme.ca/initiatives/water.html (accessed 7 April 2005).

Fortin R and Gurney S. 1997. *Phosphorus loading to the Shellmouth Reservoir, Manitoba, Canada.* Government of Manitoba.

Poff NL. 1996. A hydrogeography of unregulated streams in the United States and an examination of scale-dependence in some hydrological descriptors. *Freshwater Biology* 36:71-91.

Water Survey of Canada (2005). Hydrometric data. http://www.wsc.ec.gc.ca/hydat/H2O/ (accessed 7 April 2005)

Appendix 1: WQI parameters, WQI objective values and trend analysis computations.

WQI parameters and objective values.

Category	Water Quality Parameter	Non-compliance objective
General		
	pH	< 6.5 or > 8.5
	Dissolved Oxygen (DO)	< 5.0 mg/L
	Chlorophyll *a* (Chl *a*)	> 50 μg/L
Dissolved Solids and Major Ions		
	Total Dissolved Solids (TDS)	> 700 mg/L
	Dissolved Sodium (Na^+)	> 100 mg/L
	Dissolved Chloride (Cl^-)	> 100 mg/L
	Sulphate (SO_4^{2-})	> 500 mg/L
Nutrients		
	Total Phosphorus (TP)	> 0.1 mg/L
	Nitrate/Nitrite (NO_3^-/NO_2^-)	> 1.0 mg/L
	Total Ammonia Nitrogen (NH_3)	pH and temp. dependent[¥]
Heavy Metals		
	Total Arsenic	> 50 μg/L
	Total Aluminium	> 5 mg/L
	Total Chromium	> 20 μg/L
	Total Mercury	> 0.1 μg/L
Pesticides		
	2'4-D[¤]	> 4 μg/L
	MCPA[§]	> 25 μg/L
Microbiological		
	Fecal Coliforms	> 1000 cfu[*]/100 mL

[¥] The objective value for total ammonia nitrogen varies with temperature and pH. When temperature is less than 30°C and pH is less than 9, the objective concentration of un-ionized ammonia is less than 33 μg/L.

[¤] 2,4-Dichlorophenoxyacetic Acid.

[§] MCPA, dimethylamine salt.

[*] Colony forming unit.

Trend-analysis summary plots

There are two plots for each parameter analyzed. The first is a Time Series plot, which shows all available data. Lines are drawn between points based on chronology. The second is the Trend Analysis plot. Where possible the compliance objective is shown on these figures as a dashed horizontal line.

Previous studies have demonstrated that the Mann-Kendall and Seasonal Kendall are susceptible to serially correlated data. If data were found to be significantly serially correlated, data were collapsed to seasonal (March-May, June-August, September-November, and December-February), or biannual (May-October, November-April) averages based on the presence of serial correlation. If there was significant seasonality, then analysis was conducted using the Seasonal Kendall, otherwise analysis was conducted using the Mann-Kendall.

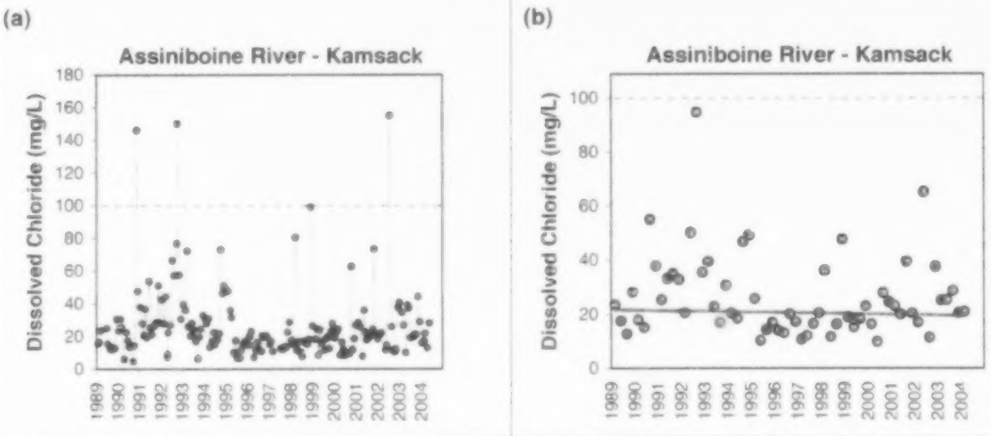
The steps taken for each parameter (i.e. data handling) are summarized in its figure caption. If there was no need to collapse data than trend analysis was conducted on individual measurements. If it was necessary to collapse the data, the figure legend notes whether data was collapsed to seasonal (4 seasons per year), or biannual means (2 seasons per year).

The seasons were defined as:

- Seasonal: four seasons: spring = March – May, summer = June – July, autumn = September – November, and winter = December – February.

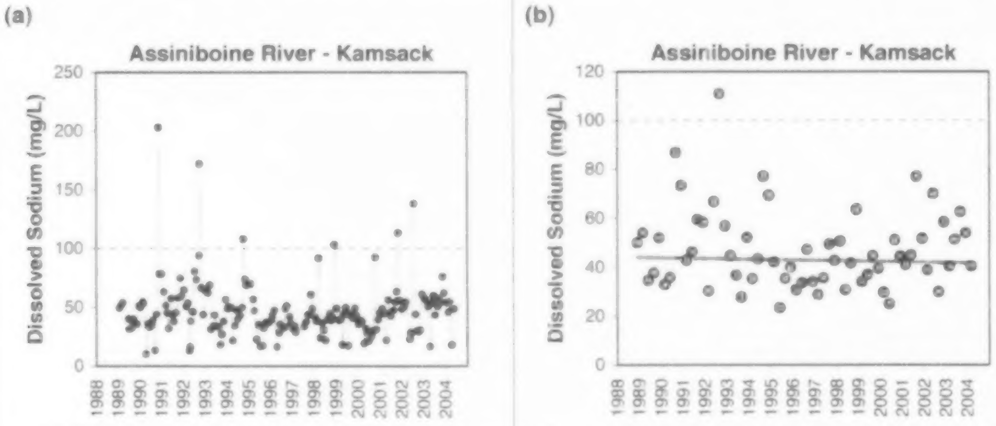
- Biannual: two seasons: summer = May – October, Winter = November – April.

Appendix 2: Trend Analysis.

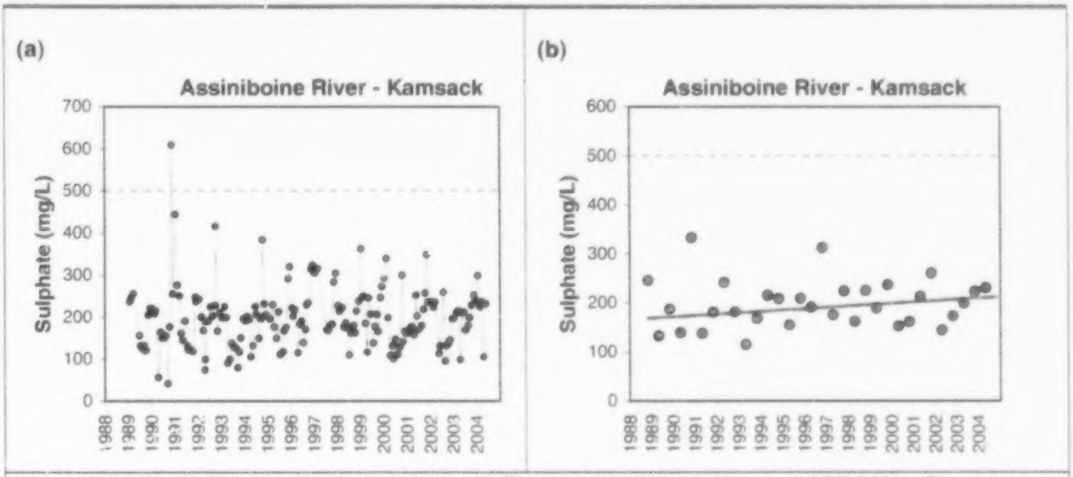


Appendix 2-1: (a) Time series for dissolved chloride; (b) Trend analysis for dissolved chloride, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.528, slope = -0.141 mg Cl^-/L/year.

Dashed line represents the objective concentration of dissolved chloride for aquatic life.

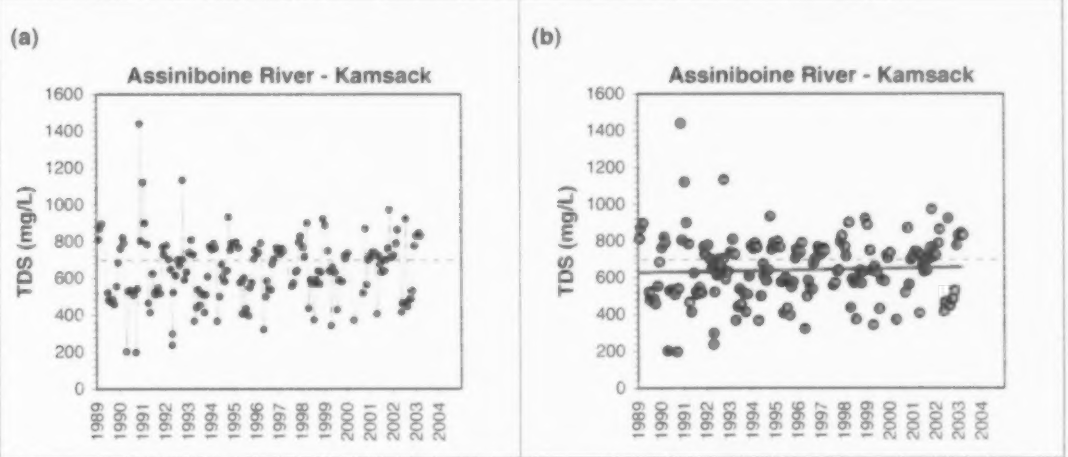


Appendix 2-2: (a) Time series for dissolved sodium; (b) Trend analysis for dissolved sodium, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.3061, slope = -0.1478 mg Na^+/L/year.
Dashed line represents the objective concentration of dissolved chloride for aquatic life.



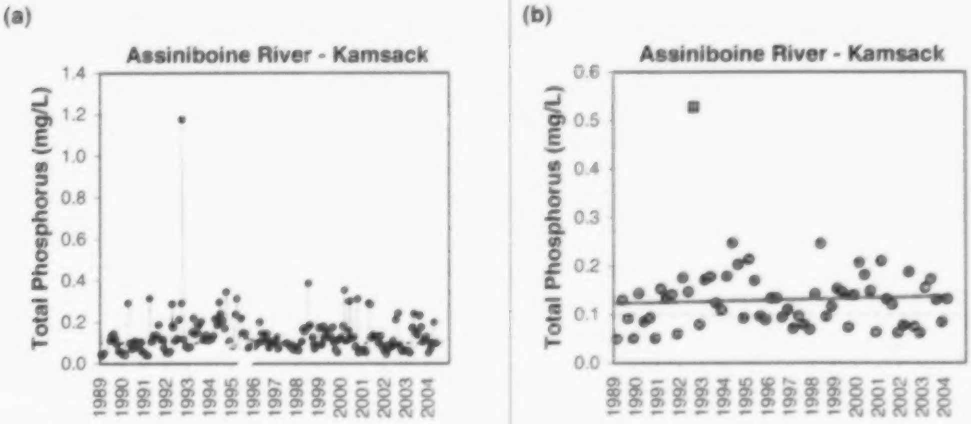
Appendix 2-3: (a) Time series for sulphate; (b) Trend analysis for sulphate, 1989-2004. Data were collapsed to two-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.9869, slope = 2.775 mg SO_4^{3-}/L/year.

Dashed line represents the objective concentration of sulphate for aquatic life.



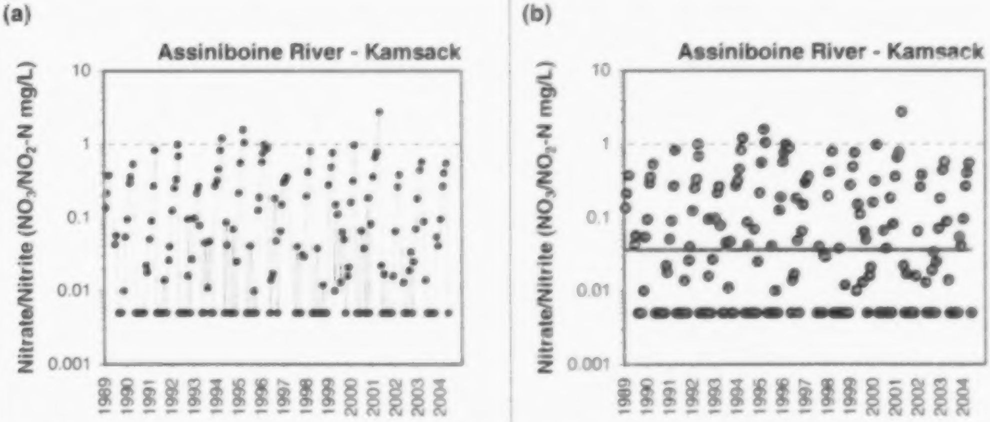
Appendix 2-4: (a) Time series for total dissolved solids; (b) Trend analysis for total dissolved solids, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.9015, slope = 2.082 mg TDS/L/year.

Dashed line represents the objective concentration of total dissolved solids for aquatic life.



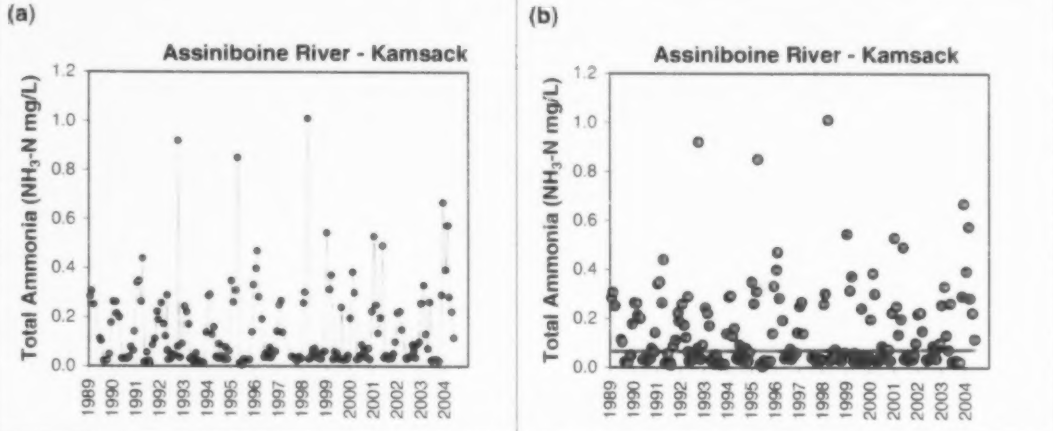
Appendix 2-5: (a) Time series for total phosphorus; (b) Trend analysis for total phosphorus, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. One outlier was removed (square symbol). The trend was not significant (α=0.05). Mann Kendall normal approx = 0.479, slope = 0.001 mg TP/L/year.

Dashed line represents the objective concentration of total phosphorus for aquatic life.



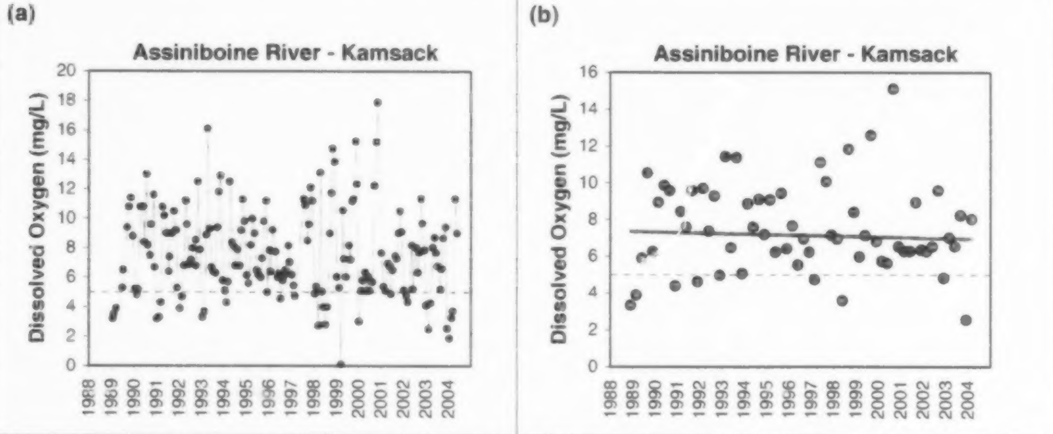
Appendix 2-6: (a) Time series for nitrate/nitrite as N. Note log scale; (b) Trend analysis for nitrate/nitrite, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.6067, slope = 0.0 mg NO_3^- +NO_2^--N/L/year.

Dashed line represents the objective concentration of nitrate/nitrite for aquatic life.



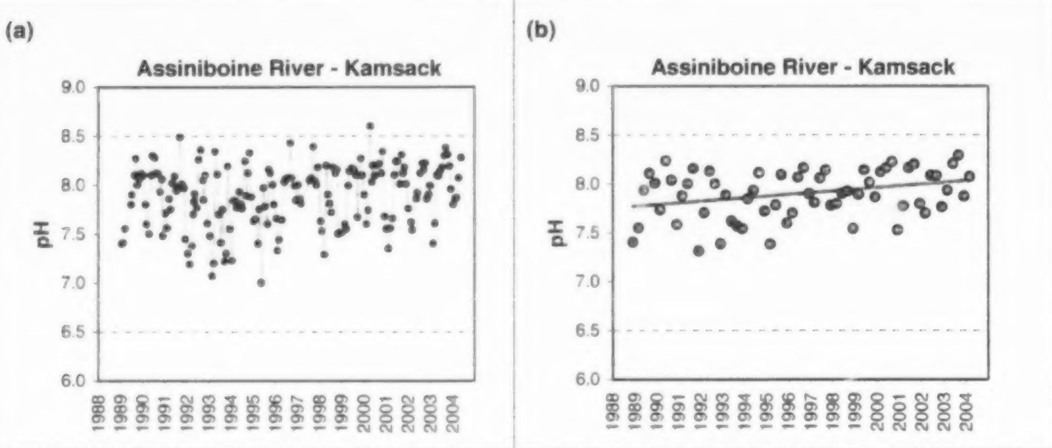
Appendix 2-7: (a) Time series for total ammonia; (b) Trend analysis for total ammonia, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.7988, slope = 0.000499 mg NH_3+NH_4^+/L/year.

Objective concentration of total ammonia for aquatic life varies with temperature and pH.



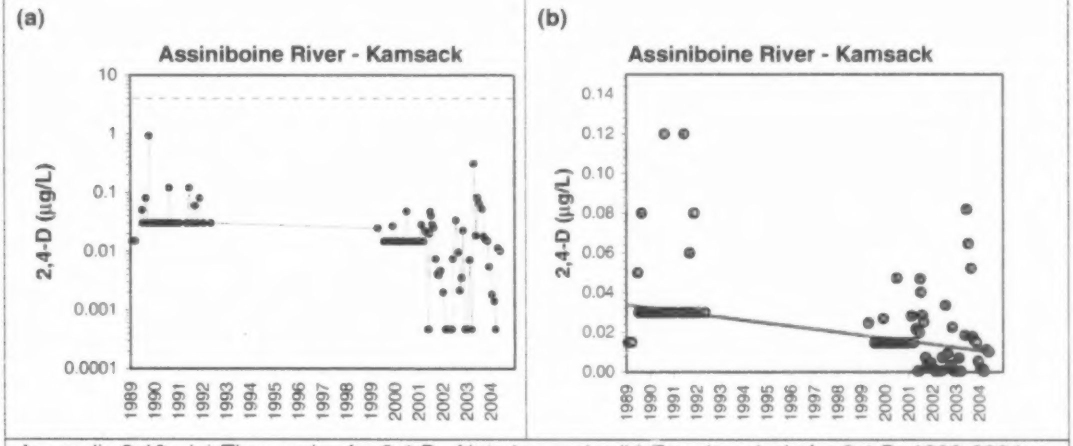
Appendix 2-8: (a) Time series for dissolved oxygen; (b) Trend analysis for dissolved oxygen, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.4984,
slope = -0.02702 mg O_2/L/year.

Dashed line represents the objective concentration of dissolved oxygen for aquatic life. Values above the line (i.e. >5 mg O_2/L) meet the provincial standards.



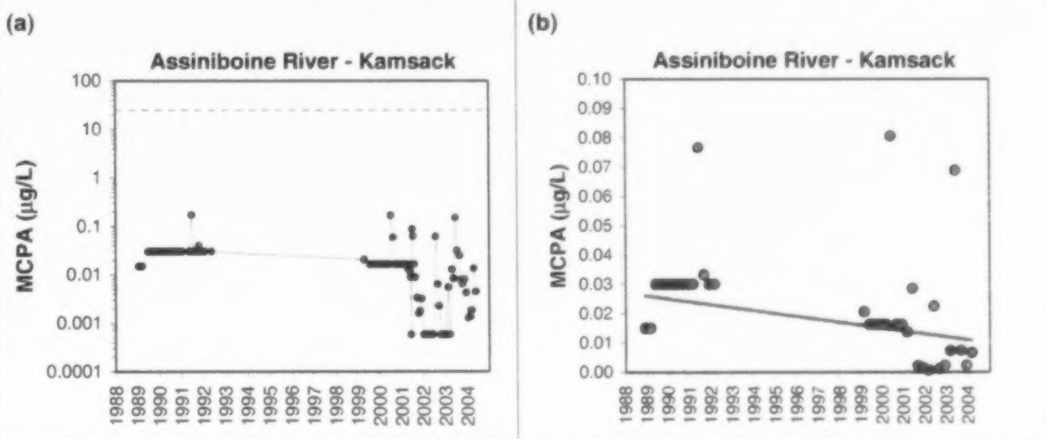
Appendix 2-9: (a) Time series for pH; (b) Trend analysis for pH, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was significant (α=0.05). Mann Kendall normal approx = 3.134, slope = 0.01737 pH/year.

The region between the dashed lines represents the water quality compliance region for aquatic life.



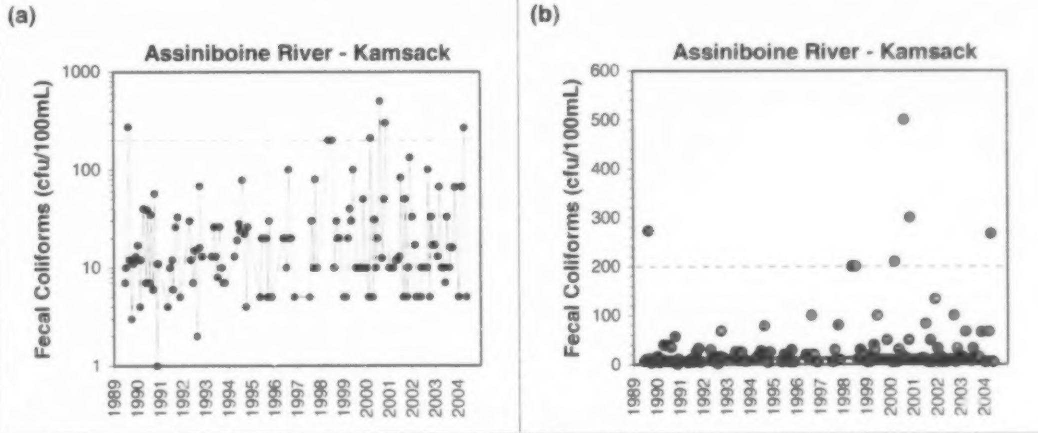
Appendix 2-10: (a) Time series for 2,4-D. Note log scale; (b) Trend analysis for 2,4-D, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was significant (α=0.05); however, changes in the detection limit may be largely responsible for this significant trend. Mann Kendall normal approx = -5.201, slope = -0.00153 µg 2,4-D/L/year.

Dashed line represents the objective concentration of 2,4-D for aquatic life.



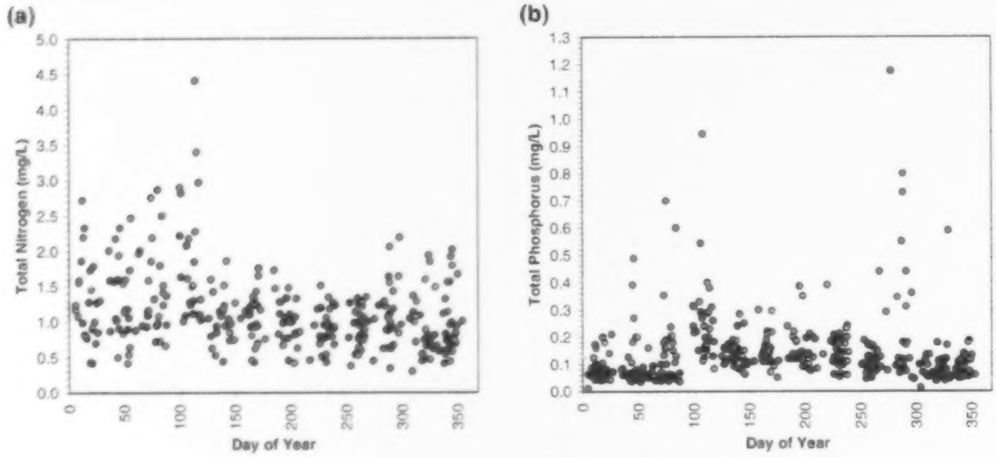
Appendix 2-11: (a) Time series for MCPA. Note log scale; (b) Trend analysis for MCPA, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was significant (α=0.05); however, changes in the detection limit may be largely responsible for this significant trend. Mann Kendall Z = -230, slope = -0.001 µg MCPA/L/year.

Dashed line represents the objective concentration of MCPA for aquatic life.

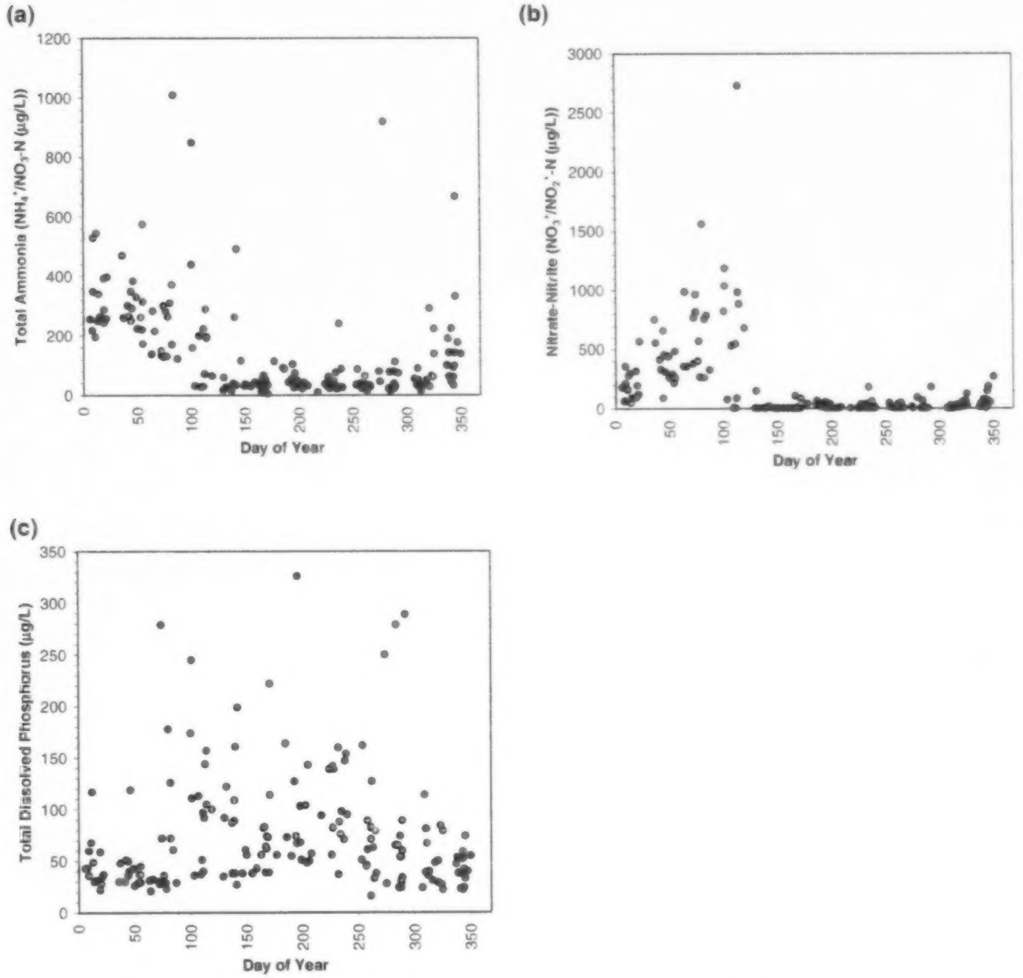


Appendix 2-12: (a) Time series for fecal coliforms. Note log scale; (b) Trend analysis for fecal coliforms, 1989-2004. Analysis was conducted using individual measurements. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 1.21, slope = 0.101 cfu/100mL/year.

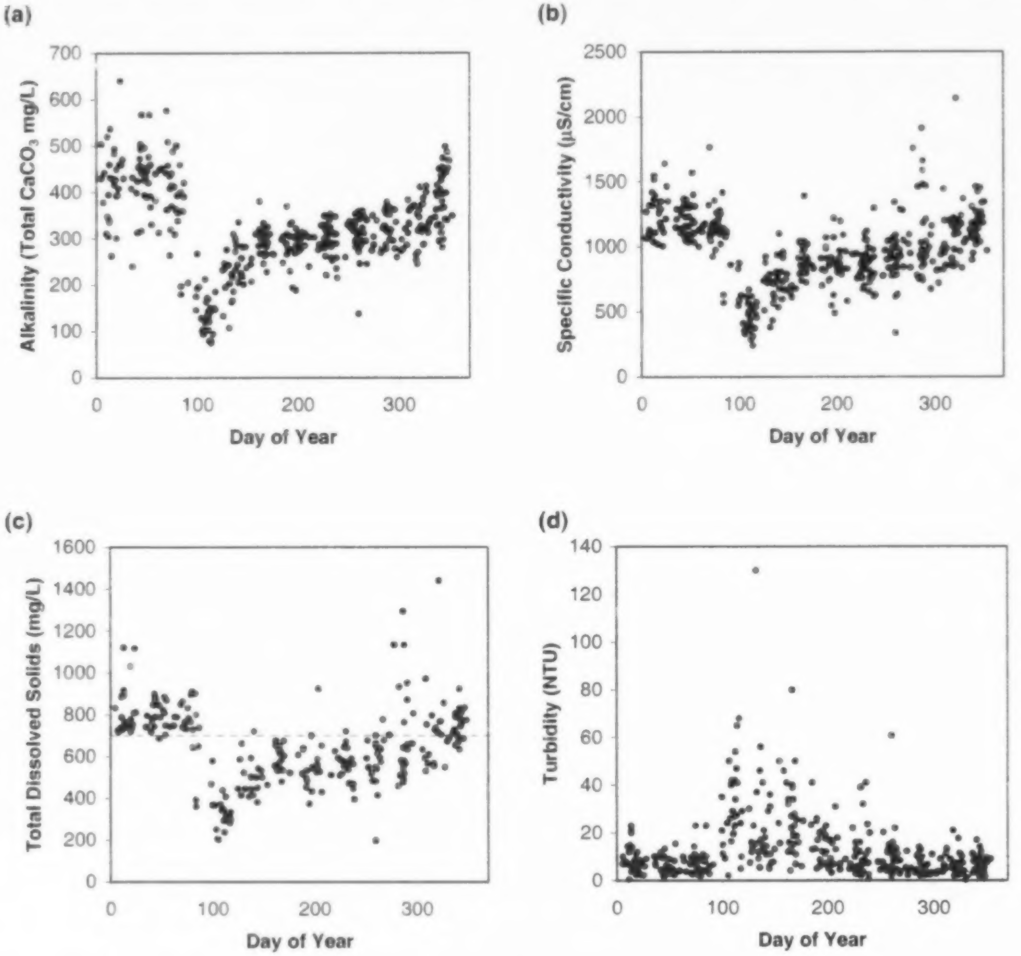
Dashed line represents the objective criteria of fecal coliforms for aquatic life.



Appendix 3-1: Assiniboine River seasonal trends at Kamsack for (a) total nitrogen; and (b) total phosphorus. 1989-2004.



Appendix 3-2: Assiniboine River seasonal trends at Kamsack for (a) total ammonia; (b) nitrate/nitrite; and (c) total dissolved phosphorus. 1989-2004.



Appendix 3-3: Assiniboine River seasonal trends at Kamsack for (a) alkalinity; (b) specific conductivity; (c) total dissolved solids; and (d) turbidity. Dashed line in (c) represents the objective concentration of total dissolved solids for aquatic life. Where available, data from 1968 – 2004.

Assiniboine River Issues Analysis

Preamble:

The Issue Analysis was prepared as a compilation of information related to each issue. It was prepared in an effort to provide more detailed information on specific issues than is provided within the Assiniboine Background Report or the Assiniboine River Source Water Protection Plan. The following should be noted:

- Some information may be already out of date since the "Issue Analysis" was largely prepared during 2005

- The document was not intended as a final polished document but rather in a draft format in order to provide information to the Technical and Advisory Committees and for future reference. The document is a series of working notes that were used to initiate the Assiniboine Source Water Protection Plan.

- There are several different authors that assisted in the preparation of this document, thus making the document read less continuous than if a single author had conducted the analysis.

Introduction:

The issues were formulated by the Advisory Committees. Most of these had been developed in the original Upper Assiniboine River Basin Study (UARB study) and had been carried forward to this planning process.

Members of the Technical Committee that were most qualified to analyze specific issues were assigned the task to prepare the analysis. Some issues were addressed by more than one technical representative.

- Once everything was compiled, the whole issues analysis document was circulated as a draft to the technical committee for review and alterations.
- The document was then circulated to the Advisory Committees for their review and comments.

The analysis of each of the issues was to be prepared considering the following information and guidelines (as prepared by the Technical Committee).

(a) Regulation versus non regulation.

- For many issues, there are provincial, federal and municipal regulatory controls already in place. However, there are often threshold values or triggers determining when the regulations come into effect. For smaller values and or private situations the regulatory aspect may be not effective.

- Then there are issues that are not regulated in manner by any level of government or agency.
- This we felt was the major role for (Best Management Practices) BMP's and where an effective education program for the public was best suited.
- It was apparent that this aspect is necessary, especially where operations are too small to have the regulatory process involved. It will take a combination of regulatory and education to address threats to source water.

(b) The following analysis/background should be considered as a guideline when reviewing each issue:

- Determine whether or not regulations apply to the issue and under what circumstances or triggers
- Which agency(s) is (are) responsible for administering the regulations
- Provide a copy of the current regulations, if any?
- Are there policies that are being utilized as well? Does the internal policy within the agency have any impact on how regulations are enforced?
- Available research or data that demonstrates the relevance to source water protection.
- Inventory if applicable (e.g. # of Intensive Livestock Operations). Inventory may be available in a variety of forms. Obviously our ultimate goal is to have the data in a GIS friendly format.

The following is the issues that were reviewed:

A. Water Quality Related Issues

i. Basin residents perceive that groundwater and surface water quality is deteriorating and must be protected by measures such as increased monitoring. . . . page 4

ii. Rural residents are concerned about access to good quality domestic and drinking water supplies and availability of low cost testing services. . . . page 9

iii. Domestic and municipal groundwater supplies need to be protected from contamination. . . . page 16

iv. Chemical Container disposal areas and landfill operations are point sources of pollution that can affect surface and groundwater quality. These operations must be properly managed and enforced. . . . page 23

v. Agricultural drainage from farm land, sloughs and wetlands can be a non point source of pollution of surface water. Agricultural runoff may contain increased sediment, nutrients and pesticides . . . . page 31

vi. Algal blooms on Lake of the Prairies are a concern . . . . page 39

vii. Livestock operations and range management practices deteriorate water quality and impact downstream users. . . . page 41

viii. Municipal lagoon operations, sewage treatment and effluent disposal can impact water quality and must be strictly managed. . . . page 47

ix. Urban Stormwater Runoff may be affecting the water quality of rivers and streams downstream of communities. . . . page 61

x. Flooding was raised an issue in that there may be specific situations where development is occurring within the flood plain which may result in potential contamination of source waters. . . . page 62

B. Watershed Health Related Issues

xi. The economic and social considerations associated with wetlands and agriculture should be better understood. . . . page 62

xii. Wetlands and uplands in the Basin are important and should be protected. The continued removal and degradation of the uplands associated with wetlands and riparian areas will place wildlife at risk. . . . page 62

xiii. Land and water management practices are affecting fish habitat. . . . page 65

xiv. Increased bank erosion of streams and rivers diminishes water quality. Increased erosion and sedimentation reduce fish spawning areas and habitat. . . . page 70

xv. Conflicts between land use for agriculture and wildlife habitat should be resolved to give better direction for water management. . . . page 74

xvi. Oil and Gas Industry are a threat to surface and groundwater in the Basin. . . page 80

xvii. The development of Regional waste management sites may be of concern to water quality.

- This issue has been moved and combined with item 4.

C. Water Quantity Related Issues

xviii. Surface water supply may not be adequate to meet future water demand. . . . page 91

xix. Groundwater demand could exceed the sustainable groundwater supply. . . . page 91

xx. The current and future ability to make good use of available water may be limited by the state or scale of the necessary infrastructure. . . . page 98

ISSUES REVIEW AND ANALYSIS

A. Water Quality Related

i. Basin residents perceive that groundwater and surface water quality is deteriorating and must be protected by measures such as increased monitoring.

- ***Prepared by Rob Walcer . . . SWA***

Examination of water quality information collected on the Assiniboine River near Kamsack suggests that the water quality is not deteriorating. However, the data sites are limited. Also, although no trends are apparent, there are concerns that the water quality is degraded, and it may have degraded over decades and thus was not apparent in the analysis conducted. This may be especially true for nutrients such as nitrogen and phosphorous, as well as dissolved oxygen levels and sedimentation values.

Historically, there have been a variety of stations monitored within the Upper Assiniboine watershed. The water quality committee that was formed during the initial Upper Assiniboine River Basin Study concluded the following

> *"... a review of the available data of several water bodies in the Upper Assiniboine River Basin indicted that in general the water quality is suitable for its expected uses. There are several areas where limitations to uses such as irrigation are evident. It is important to note that in some cases the assessment is based on a limited quantity of data.... The Prairie Provinces Water Board (PPWB) sampling site on the Assiniboine River near Kamsack provides an ongoing measure of water quality trends in the upper reaches of the Basin and provides the only regular ongoing up-to-date data."*

In the UARB study, a trend analysis was completed for the PPWB station near Kamsack. The purpose of the trend analysis was to determine if any long-term increasing trends were present in the data. The trend analysis was conducted by Environment Canada and was complete for the period from 1981 to 1997. The result of the trend analysis indicated that no parameters showed a long-term increasing trend. A comparison of the water quality results to the PPWB Water Quality Objectives was completed to identify water quality concerns in the river. The study stated that:

> *"The dissolved oxygen objective was periodically not achieved, mainly under winter ice conditions, which is often typical of intermittent prairie streams. The dissolved manganese objective was also exceeded but mainly during the winter months. The total phosphorus objective, established in 1990, was occasionally exceeded but this objective is out dated and under review."*

The Water Quality Committee of the initial UARB study recommended the following:

1. Monitoring for dissolved oxygen, total phosphorous and dissolved manganese should continue at a frequency that is capable of detecting long-term trends in water quality. This is recommended since levels of these variables already exceed the PPWB Water Quality Objective for the Assiniboine River and could potentially have a detrimental effect on downstream users in the Basin.

2. Methods of operational effluent release procedures in coordination with Assiniboine River stream flows should be reviewed. A reduction of nutrients in the Assiniboine River may have the potential to reduce accelerated aquatic weed growth in the river.

3. A monitoring program should be carried out to collect additional data in order to confirm the current status of water quality conditions in the Basin. Water quality monitoring carried out on the major waterbodies in the Saskatchewan portion of the Upper Assiniboine River Basin has provided some baseline data for the period 1980 to 1998. However, the sampling frequency has been highly variable and some of the results are quite dated.

What monitoring is being conducted within the Watershed?

Water quality monitoring is limited within the watershed. At present there is regular monitoring conducted at two locations within the watershed. These stations are located at the following locations:

a. A Sask Environment station on the Assiniboine River near the Town of Kamsack drinking water treatment plant. Monitoring is conducted monthly approximately eight times per year with metals and herbicide/pesticides being sampled quarterly. Monitoring of this station is conducted by Saskatchewan Environment.

b. The PPWB station on the Assiniboine River at highway #5. This station is located downstream of the confluence of the Whitesand River and Assiniboine River. Monitoring is conducted on a monthly basis and is conducted by Environment Canada.

Additional monitoring being conducted within the watershed include:

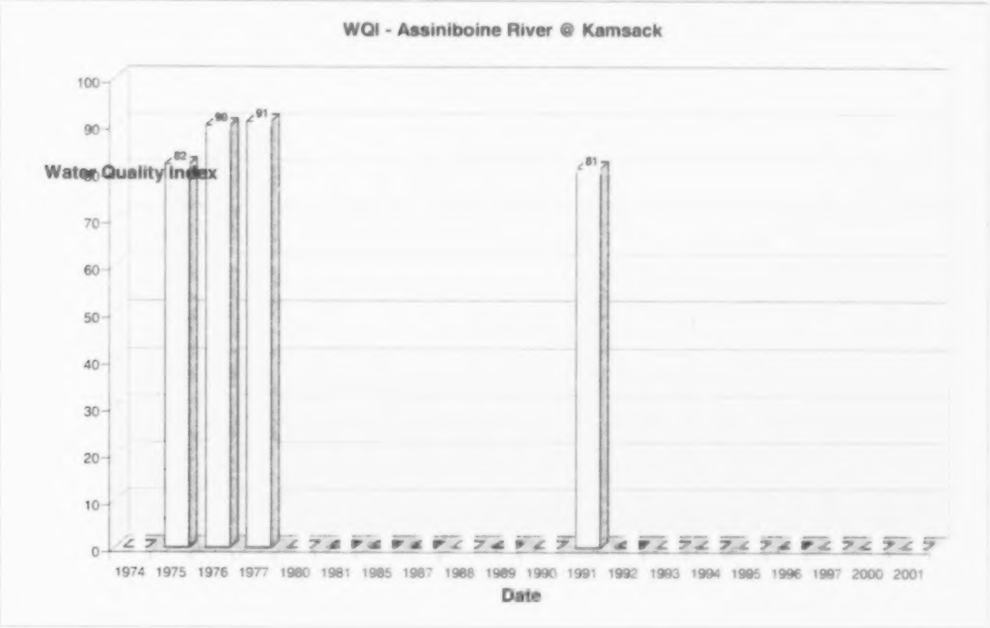
1. Good Spirit Lake – The Watershed Authority along with the Friends of Good Spirit Lake have been water sampling since 1999. The monitoring program has changed slightly over time but there is baseline data available for a station located in the middle of the lake. A summary report is completed annually. The Friends of Good Spirit Lake have also contracted the National Hydrology Research Centre to conduct a sediment study of the lake and the final report was completed in the winter of 2005/06.

2. Spirit Creek Monitoring Committee – Formed by the Saskatchewan Agriculture Food and Rural Revitalization this committee is a group of local citizens concerned about the development of pig ILO's in the area. The group conducts water sampling of runoff and private water supplies in the local area. As well the committee has contracted a researcher from the University of Saskatchewan to conduct an odour study. The committee has also contracted an agrologist to study the impacts of injecting liquid manure have on the receiving soils. The committee is planning on completing a report on their activities and findings around June 2006. The committee website can be found at http://spiritcreek.ca.

Is there any water quality data for the headwaters of the Assiniboine River?

There is limited water quality information available for the headwaters of the Assiniboine River. There is a station located 3.3 km west of the Rockford church that was sampled once during 2001 and twice during 2002. The number of samples is insufficient to be used to assess changes in water quality.

Included in the UARB study, a water quality index was applied to the Saskatchewan Environment station at Kamsack. The application of the water quality index was limited to four years due to the limited amount of data available. The water quality index rating is 'good' at this station. The review of the water quality index indicates that the water quality is impaired by high levels of total phosphorus and total dissolved solids which usually exceed the objective of 0.1 mg/L (total phosphorus) and 700 mg/L (total dissolved solids).



As part of the updating for the "background report" for the watershed planning process, the Saskatchewan Watershed Authority analyzed existing available water quality data in the provincial database for the Assiniboine River. The data was reviewed and assessed for long term trends in water quality.

The complete report, "*Water Quality and Water Quality Trends for the Assiniboine River at Kamsack*", with accompanying graphs and tables can be found in the Assiniboine River Background Report or as part of the Assiniboine River Watershed Source Water Protection Plan.

The following is a summary of the report findings:

- The water quality on the Assiniboine River at the PPWB station near Kamsack was evaluated using the Water Quality Index.
- The results shown in the following figure indicate that for the years 1989 to 2004, the WQI was found to be consistently fair to good. There was not a great deal of variation in the WQI from year to year or over the whole review period.

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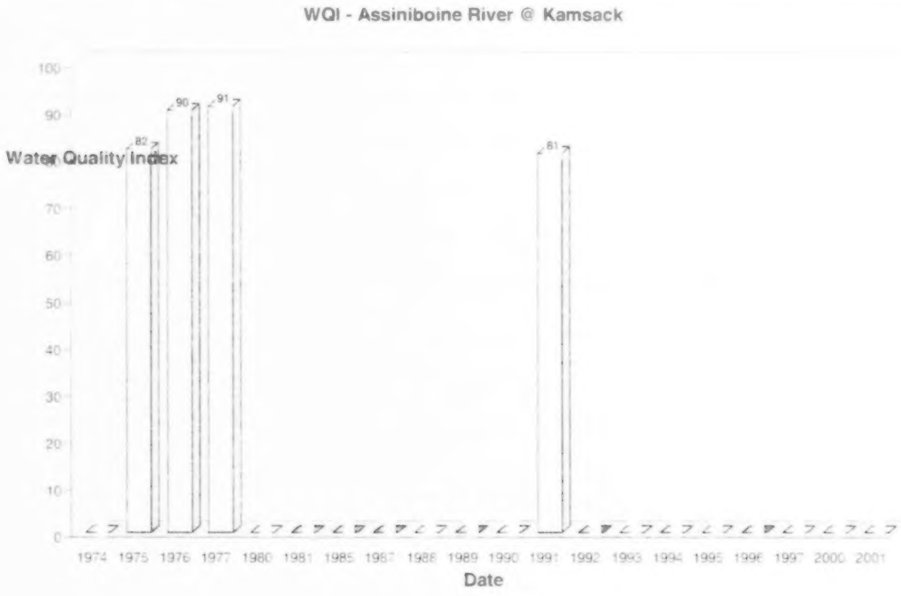

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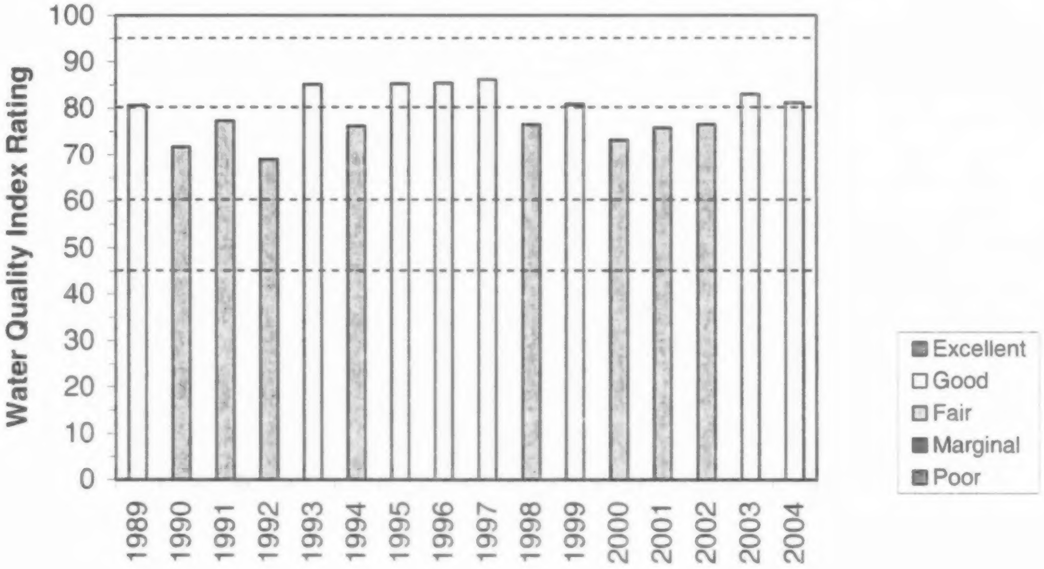
- Total Phosphorous often exceeds its objective (for the Water Quality Index calculations).
- Total Dissolved Solids frequently exceeded its objective and dissolved oxygen occasionally did not meet its objective.
- There are no increasing or decreasing trends apparent in the water quality parameters over the time period reviewed.



Dashed lines correspond to WQI ratings (95-100 = 'Excellent', 80-95 = 'good', 60-80 = 'fair', 45-60 = 'marginal', less than 45 = 'poor'

ii. **Rural residents are concerned about access to good quality domestic and drinking water supplies and availability of low cost testing services.**

- ***Assigned to Sunrise Health & Sask Environment***
- *This information is from the original Upper Assiniboine River Basin Study.*

Groundwater is normally the first choice of water supply for rural residents where it is available in sufficient quantity and quality. Groundwater quality is much more uniform throughout the year than is surface water quality, allowing for consistent water treatment where treatment is needed. However, in many parts of the Basin, groundwater cannot supply adequate quantities for domestic wells, or the chemistry of some shallow groundwater supplies makes it unsuitable for consumption. In these areas, many residents depend on dugouts for farm and household use. Dugouts are drought sensitive and prone to water quality problems due to the nature of the runoff which fills them.

Groundwater protection from man-made sources of contamination may be enhanced through measures such as:

- proper well citing and well construction, sealing abandoned wells, testing well water and taking steps to prevent contamination in recharge areas.
- Until specific groundwater recharge information is available for a particular parcel of land, landowners should be encouraged to use land management practices that have a positive affect on maintaining good quality water.
- Where natural groundwater is hard or contains high concentration of sodium or sulphate, home-scale water treatment may or may not be feasible.

If a surface water supply source is used, water quality can be enhanced by protecting the quality of runoff into the dugout or stream.

- Runoff into dugouts should be filtered by vegetation to minimize sediment and sediment-borne contaminants and nutrients.
- Livestock should be kept away from dugouts to avoid contamination of the water.
- In a similar manner, vegetated riparian zones along streams help to maintain stream water quality.

Water quality tests should be conducted regularly on domestic supplies. However, the costs of water quality testing to the individual are in some cases a deterrent to regular water quality monitoring. The onus is usually on the individual to take the sample, request the type of information desired and pay the provincial lab (testing via the provincial lab is subsidized by the Province, fees collected account for 70% of the actual costs) or a private laboratory at the full price for analysis. Then, it is up to the individual to interpret the results and to determine a possible course of action. In Saskatchewan, Saskatchewan Watershed Authority has a program to encourage water quality testing of individual rural domestic water supply (including dugouts and wells) for a subsidized fee (currently $100). A technologist will sample and arrange for analysis of the raw water for major ions, bacteria, nutrients, physical parameters, trace metals and prepare a report which provides an interpretation of the analysis and advice on water supply management.

While some regulations are in place for protecting the vital groundwater resource, monitoring of groundwater, particularly in the most sensitive areas, must be implemented and carried out in order to detect and track any water quality changes.

Aquifers could be monitored regularly for possible contaminants such as pesticides and once any areas of concern are identified, long-term monitoring and possible corrective actions may, if practical, be implemented. Without good water quality information, it will be very difficult, if not impossible, to determine water quality trends.

If water analysis was available at a reduced cost, landowners might be more inclined to test their groundwater supplies on an annual or biannual basis. This information can also be used in the development of an overall groundwater availability/water quality database and assist in determining what future monitoring is required. (Subsidized analysis are currently available through the Provincial Lab and SWA). Fees for a total coliform/nitrate test are currently ~$25 (increased from $15 in 2004) through the Provincial Lab. In the past this service was provided free of charge. The testing provided by SWA recoups about 1/3 of the analytical costs and then there is the additional staff time.

The Saskatchewan Research Council (SRC) also offers analytical services. They have a $40 lab minimum. A total coliform test costs ~$28. SRC has a "water potability" analysis which includes nitrates and total coliform bacteria for $45.

The UARB Local Watershed Committees identified the need for coordinated collection and distribution of information which should be made available to the public. The various agencies responsible for groundwater information and water quality should be encouraged to share information and develop a joint database of the present status of groundwater and quality. This will require extensive cooperation and sharing of information among the various agencies and a long-term commitment from governments to support the pooling of information.

Saskatchewan Environment

SE is the principle regulator of municipal waterworks and all privately owned (publicly accessible) waterworks that have a flow rate of 18,000 litres or more per day. SE will also regulate certain pipeline systems.

- Municipalities own, and are responsible, for municipal drinking water facilities and their operation. Water sample submissions are required for testing.
- Hygienic Use Systems provide water to be used for hygienic purposes by humans, (including bathing, showering, personal hygiene but not including swimming). Hygienic use must not include a human consumptive use (drinking, oral hygiene and food preparation making ice cubes, etc). Water provided for hygienic use (where permitted) must be provided by a system approved by Saskatchewan Environment and that system must be maintained in accordance with the regulations by the permittee of the works.

Sask Environment document "Municipal Drinking Water Quality Monitoring Guidelines, EPB 202, Edition 2" should be referenced. It is available 'on line' at

- http://www.se.gov.sk.ca/environment/protection/water/EPB%20202%20-%20Municipal%20Drinking%20Water%20Quality%20Guidelines.pdf

Monitoring Factors

There are a number of factors that should be considered during the development of a drinking water monitoring schedule. Samples must be collected in an appropriate manner and analyzed using an acceptable method to ensure representative results. The main points to consider when developing monitoring guidelines are:

- water supply variations and susceptibility to quality changes (for example, surface water will be subject to seasonal and hydrological changes while groundwater is often less variable on a short term basis);
- treatment capabilities and performance of the treatment facilities;
- vulnerability of the water supply to potential contamination:
- the need for and capabilities of conducting on-site measurements;
- past trends in water quality information;
- the laboratory capabilities and cost of monitoring compliance by the owners;
- minimization of effort while providing adequate surveillance;
- size of population (as population increases, users tend to be more diverse, there are more consumers, the systems are more complex, and subject to contamination);and
- the availability of water quality data and information on raw water sources should be considered when establishing drinking water monitoring requirements (Saskatchewan Environment has a good database on a wide range of parameters that are frequently analyzed at designated surface water sites in the province).

- As part of a special Provincial monitoring investigation in 2001, raw water supplies were sampled for each community.

An example of the guidelines

2.1 Bacteriological

Minimum bacteriological monitoring requirements for waterworks relying upon surface and ground water supplies are shown in Table 1.

Table 1: Bacteriological (Total Coliform & Background) Monitoring Requirements

Population	Groundwater Source	Surface Water and Blended Source
0-100	1 per month	2 per month
101-500	2 per month	1 per week
501-2,000	1 per week	1 per week
2,001-5,000	1 per week	6 per month
5,001-15,000	2 per week	3 per week
15,000-50,000	1 per 6,000 pop. per week	1 per 4,000 pop. per week
>50,000	1 per 15,000 pop. per week	1 per 12,000 pop. per week

Bacteriological determinations, particularly using total coliform bacteria as an indicator of the potential presence of pathogens, has been a standard monitoring tool for many years. Typically, monitoring requirements have been related to the population served by a distribution system. Other factors could include the nature of the supply, its susceptibility to bacteriological contamination, and the historical bacteriological records (submissions and incidence of positive detections). Bacteriological water quality monitoring is required for systems supplying water for human consumptive use or hygienic use. Sampling locations should be at representative locations in the distribution system. For those waterworks subject to seasonal population changes the bacteriological monitoring frequency should be adjusted on a seasonal basis in accordance with the frequencies outlined in Table 1.

For further details, consult the “Municipal Drinking Water Quality Monitoring Guidelines”.

Sask Environment initiated the five-year phase-in period of the Mandatory Operator Certification Program on July 15, 2000.

By July 15, 2005, owners of waterworks and/or sewage works, other than those owners of waterworks producing or supplying water intended or used for hygienic use, must ensure the operation, maintenance and repair of these works is under the direction of an operator certified at facility class level.

A facility's main operator must be appropriately certified at facility class level in any or all of the following applicable categories:

- water treatment;
- water distribution;
- wastewater treatment; and/or
- wastewater collection.

Saskatchewan Health

Through the regional health authorities, Sask Health will regulate semi-private waterworks that have a flow of less than 18,000 litres per day.

These include on-site water systems serving restaurants, motels, campgrounds, small parks, municipal wells with no distribution system. Smaller non-municipal pipeline systems will also be regulated by Health. About 150,000 people in the province rely on private waterworks including systems at farms, rural homes and cottages. Although private waterworks are not regulated, health regions will interpret test results and provide health-related water treatment advice.

- The Assiniboine River Advisory Committee felt that smaller communities are struggling with the costs to run their systems according to provincial guidelines and regulations. This pertained to both regular water quality testing and certified plant operators.

Private

Private water supplies should be tested annually for total coliform bacteria and nitrate. There are many other tests that may be required depending upon the type and location of the water source. For example, dugouts and shallow wells on farms are susceptible to contamination by pesticides. There are also concerns with cyano-bacterial blooms that can form and have the potential to produce a number of different toxins that can affect short and long-term health. Some groundwater sources contain elevated levels of arsenic.

To have your drinking water tested for total coliform bacteria and nitrate you must use a special, sterilized container. The Provincial Laboratory distributes sample bottles to RM offices and public health offices throughout the province.

- If you wish to have your water tested for other parameters, please refer to website: http://www.saskh2o.ca/PDF/Health Environmental Services.pdf for sample container requirements

- The cost varies depending upon the type and number of tests being performed. For example, a drinking water test package (total coliform bacteria and nitrate) costs $26.75 (7% GST included).
- Service charges for other tests may be found at www.saskh2o.ca/PDF/Health Environmental Services.pdf.

The two tests for total coliform bacteria and nitrate indicate that the water is safe ONLY with respect to contamination by these parameters. It does not indicate anything else regarding the quality or safety of the water supply. For example, water that is found to be acceptable for bacteria and nitrate may contain pesticides or arsenic. It is impractical and expensive to test all private water supplies for all possible contaminants. If a problem is suspected or you have a concern regarding the safety of the water supply, further specific types of testing can be requested. Contact the public health inspector in your Regional Health Authority for specific advice.

Saskatchewan Watershed Authority

The Watershed Authority delivers the Rural Water Quality Advisory Program (RWQAP) that has, for many years, improved the quality and safety of individual water supplies in rural Saskatchewan. The Authority samples and analyzes water from private water supplies, and advises on the health and aesthetic implications of the analysis. Advice is also provided on beneficial management practices proven to protect and improve raw well or surface source water. In 2002, 550 clients across rural Saskatchewan received this service, bringing the program total to 2, 027 clients served since the program's inception in 1997.

In rural Saskatchewan, most people rely on private water sources for their daily water needs. Whether the raw water is from a ground or a surface water supply, these supplies are often of poor quality and require some form of treatment to make them safe and aesthetically acceptable.

Prior to the establishment of the RWQAP routine testing for trace metals such as arsenic, uranium and selenium was not normally completed The results of the Rural Water Quality Advisory Program indicate on a provincial wide basis:

- Nitrate:11.8%,
- Total coliforms:33.3%,
- Arsenic: 5.5%,
- Selenium: 8.9% and
- Uranium: 13.7%

exceeded the established guidelines by the percentages noted above.

The *Rural Water Quality Advisory Program* is a province-wide service designed to help rural residents assess and improve their water quality. Through the program, a qualified technologist samples the raw water supply. Samples are analyzed at a certified laboratory for an extensive number of test constituents.

- Groundwater is tested for 31 constituents including major ions, dissolved organic carbon, nitrate, trace metals, fecal and total coliform.
- Surface water supplies are tested for 27 constituents including major ions, dissolved organic carbon, nutrients, chlorophyll *a*, as a measure of algal biomass, iron, manganese, color, conductivity, pH, mercury, fecal and total coliform, and heterotrophic plate count.

Once results are received, the technologist follows-up to explain the results and their implications, and provide guidelines on how to improve or protect the raw water source, whether it is a ground or surface water supply.

The program is available from all Saskatchewan Watershed Authority offices to anyone who relies on a private water system including farmers, ranchers, acreage owners, northern operators and trailer park residents.

Based on the results of the RWQAP, the Watershed Authority recommends that all private water supplies should have a complete analysis completed annually that includes health and toxicity parameters (ie metals). Repeating the health and toxicity testing is important in determining if these important parameters are changing

Water Services Water Testing

Drinking Water: Testing Privately Owned Systems

Drinking water can be tested by the Saskatchewan Provincial Health Lab in Regina (Changes for Private Sample Submission); or subsidized testing for private system owners may be available through Saskatchewan Watershed Authority's Rural Water Quality Office in Saskatoon, 330-350 3rd Avenue North, S7K 2H6, Telephone (306) 933-7442, Fax (306) 933-6820.

Provincial Laboratory – Saskatchewan Health

The Laboratory performs a wide range of chemical, bacteriological and physical tests on water. The cost varies depending upon the type and number of tests being performed. If you require water tested for total coliform bacterial and nitrate, you must use a special sterilized bottle available from both RM and public health offices throughout the province. Information on Bacteriological Sample Submission by Regulated Operators (to order requisitions or sample containers fax 306-798-0071).

Water Analysis Laboratories in Saskatchewan

(Accredited or seeking accreditation

iii. Domestic and municipal groundwater supplies need to be protected from contamination.

Non-Point Agricultural Contaminant Sources to Groundwater

Non point source pollution generally results from runoff, precipitation, infiltration, and seepage of contaminants away from the source. Agricultural activities that contribute to non-point source pollution include the application of inorganic fertilizers, pesticides, herbicides, manure, and decomposition of organic matter. The potential problem has increased with intensive agriculture practices and industrial development.

Shallow, unconfined aquifers are most susceptible to contamination from land-use activities, as they generally exist at shallower depths than confined aquifers. The upper boundary of the unconfined aquifer is represented by the water table, which is susceptible to contamination by land-use activities. Often these aquifers are overlain by coarse textured sediments such as sand, silt, and gravel. Coarse textured soils pose a greater potential threat to contamination compared to fined textured soils because of the porosity and lack of sorption by the sediments. In sorption, solutes are removed by the soil matrix. Fine sediments such as clay contain greater pore spaces, which will bind to the contaminant and reduce or slow the movement of the pollutant.

Transport of Contaminants to Groundwater

The transport of contaminants into a shallow aquifer depends on several factors such as absorption, soil properties, application rate and method, precipitation and loading. Movement of contaminants into groundwater can occur through leaching after precipitation or by spills. Contaminants may also be introduced into the groundwater by direct routes such as abandoned wells. These wells are ones, which are no longer in service but have not been properly sealed. Abandoned wells can act as conduits to the water table. These pathways are significantly important because the natural protection offered by material overlying the aquifer is lost. Wells with poor construction, lack of grouting around the casing, located in a low area, and surface ponding may contribute to groundwater contamination.

Nitrates

One of the most important contaminants derived from agricultural activities is nitrogen. Nitrates is a compound containing the element Nitrogen. The most common sources of nitrate are from inorganic fertilizers, municipal and industrial wastewaters, wastewater lagoons, landfills, feedlots, and septic systems.

Although nitrates are naturally occurring in drinking water, elevated levels in groundwater usually result from human activities, related to sewage disposal, and agricultural practices such as the use of inorganic fertilizers. The accumulation of nitrate in the environment and in groundwater can be caused by non-point source runoff due to over application of nitrogenous fertilizers and manure. In many cases, it is often difficult to identify the source of nitrate found in an individual well because nitrates move with the flow of groundwater. The exact source may be located at a considerable distance from the well.

Nitrates are highly soluble in water and are susceptible to leaching. The leaching potential of nitrates is a function of soil type, crop, climate, tillage practices, fertilizer management, and irrigation and drainage management. Because nitrate salts are very soluble, nitrate is highly mobile in soil and will migrate to the groundwater table when in excess of the amount consumed by the plants. The fate and transport of nitrates is dependent on the biological activity in the subsurface horizon. In the soil, nitrate may degrade into nitrite under anaerobic conditions by denitrification by soil microorganisms under anaerobic conditions.

Pesticides

The fate and transport of pesticides is dependent on the geologic and hydrogeologic properties and agronomic processes. To date, only a few studies that focused on the impacts of pesticides on shallow water wells in Saskatchewan (Maathuis, 1987; Clifton Associates Ltd., 1996). Maathuis (1987) examined groundwater contamination by pesticides and herbicides in shallow wells in the Nokomis aquifer. Based on water quality data, there were no evidence of contamination from pesticides and herbicides at the Nokomis site. Clifton Associates Ltd. (1996) performed water quality analysis from 86 shallow water wells completed in surficial aquifers within the Rosetown mapsheet (72O). They found that approximately 93% of the water samples analyzed for pesticides were below analytical detection levels. The remaining 7% of the wells detected pesticides were located on farms that had previously used agricultural chemicals. Concentrations of the pesticide from these wells were all below 1 ug/L.

The major process of pesticide migration is by leaching. The susceptibility of pesticides to leaching depends on site-specific conditions and the physical and chemical properties of the pesticides. Examples of site-specific conditions that may affect the process of leaching of pesticides include soil characteristics, tillage practices, crop rotations, irrigation practices, and properties of the pesticide. Soils that have the potential to shrink and swell may contain cracks forming macropores, which provide a direct conduit for the pesticide to reach the groundwater table. Pesticide properties such as half-life, and absorption ratio will have an impact on the migration of the contaminant through the soil horizon. Once the pesticide enters the soil horizon, the fate and transport is dependent on sorption and persistence. The local geologic conditions be a factor in the absorption and immobilization

Protection of Water Wells

Proper sighting of the well will ensure the safety and extended life of the well but the location is at the discretion of the well owner. The well should be situated in an elevated area with the ground surface sloping away from the well to prevent contamination. This will reduce the possibility of surface ponding and the potential for water to flow outside the casing, which may contaminate the well. The well should also be located at a distance from any potential contaminant source. For example, the well should not be located near chemical storage, livestock, and feed barns.

The wellhead and annulus of the well should be properly sealed to protect the water source from contamination. Improperly sealed wellheads provide a direct path of contamination to the aquifer. Other considerations for future developments in the vicinity of a proposed well site is that wells should not be located in well pits or buildings and should be easily accessed for maintenance and repairs.

Abandoned Wells

Proper decommissioning of water wells is important to prevent contamination from entering the aquifer and eliminating any physical hazards to humans and animals. The purpose of water well decommissioning is to restore as closely as possible the geologic conditions prior to well development. The soil horizon acts as a physical barrier and a natural filtration system by removing potential contaminants through absorption and decomposition of organic and inorganic contaminants. The contaminant is removed or impeded from reaching the groundwater table. A direct route for surficial contamination to pollute groundwater occurs when a water well is improperly sealed. Improperly sealed wells acts as a conduit for surficial contaminants to reach the water-bearing zone. After the groundwater has been contaminated, natural groundwater gradients will transport these contaminants away from point and non-point sources. Possible point sources of contamination include landfills, effluent lagoons, septic fields, petroleum storage facilities, intensive livestock operations, etc. Non-point contaminant sources include agricultural fertilizers, manure spreading, pesticides and herbicides, highway salts, etc. Groundwater remediation usually is not economically feasible and in some cases, nearly impossible.

Regulation of water well abandonment is managed by the Saskatchewan Watershed Authority. Water well abandonment and decommissioning procedures are administered through the Groundwater Regulations under the *Groundwater Conservation Act*. The Regulations encompasses well abandonment and procedures for all test holes, observation wells, borings, municipal and domestic water wells in the Province. Although the abandonment of water wells is regulated by the Saskatchewan Watershed Authority, effective enforcement is not realistic. The primary responsibility of abandoning water wells relies upon the well owner while the work should be completed by a water well contractor.

The decommissioning of water wells requires filling and sealing the well with a suitable uncontaminated material to the manner as to prevent vertical movement of water into the well. Sealants are used to provide a watertight barrier to inhibit vertical flow of potential contaminants. Sealants include Portland cement based grouts, bentonite clay, or a combination of the two. The original well casing should be removed, if possible. In cases where the well casing cannot be removed, the bottom 1 foot of the wells should be sealed with bentonite and backfilled to 10 feet below ground surface with an impervious material for large diameter wells. A 1 foot layer of bentonite seal or aggregate is used and backfilled to the surface. For small diameter wells, the decommissioned well should be pressure grouted with a high pressure grout or cement and the upper 10 feet removed. The well is capped and sealed with a 1 foot bentonite layer and backfilled to the surface with non-contaminated impervious material. The surface is mounded to prevent ponding of water.

A program for water well abandonment in Saskatchewan is currently under development. The Saskatchewan Watershed Authority provides information and guidance in decommissioning water wells. Currently, there are no financial assistance programs for water well abandonment.

Aquifer Vulnerability Maps

Aquifer vulnerability maps provide a useful tool in illustrating the spatial distribution of the vulnerability of aquifers to contamination. These maps assist in planning land use activities thereby minimizing water quality impacts. In general, groundwater vulnerability maps illustrate the area vulnerable to contamination. The maps are done on a regional scale and are therefore not suitable to evaluate specific sites.

Several methods have been developed to evaluate the vulnerability of an aquifer system (Van Stempvoort et al., 1993). To date, there is no universally accepted method for mapping the vulnerability of an aquifer. Previous groundwater vulnerability mapping methods used qualitative methods, which only considered surficial geology and soil survey information (Ontario MOE, 1982). Roeper (1990) mapped the vulnerability of aquifers in the Regina area. The sensitivity rating was based on the thickness of the confining layer and indirectly considered the hydraulic conductivity of the overlying material. A sensitivity classification of extreme to high was based on 0 to 5 meters of protective clay or till overburden. A classification of moderate was based on the thickness of the protective clay or till overburden between 5 to 10 meters. A low sensitivity was based on the thickness of the overlying clay or till greater than 10 meters.

A complex groundwater vulnerability method widely used is the DRASTIC method (Aller et al., 1987). The DRASTIC system considers seven parameters. These include depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone, and hydraulic conductivity of the vadose zone. Each parameter is given constant weights. Detailed description of each weight and rating is described by Aller et al. (1987). Several redundancies occur in the parameters. For example, the soil media and vadose zone parameters overlap, since the soil media is a subset of the vadose zone. The hydraulic conductivity parameter is also redundant since it is derived from the aquifer media parameters. In general, the DRASTIC model is quite complex in its selection of parameters with its arbitrary assignment of relative weights to these parameters.

The Aquifer Vulnerability Index (AVI) method was developed by Van Stempvoort et al. (1993). AVI was developed as a tool for mapping the vulnerability of aquifers from surficial contamination at a regional scale. The AVI method has been used to map aquifer vulnerability along the Alberta-Saskatchewan border and Saskatchewan-Manitoba boundary (Grove and Androsoff, 1994; Grove and Androsoff, 1995) and the Yorkton area (Maathuis, 1999). Both investigations used water well information from past drilling to determine the thickness of the overlying layers but using different statistical analysis of the data. Grove and Androsoff (1994, 1995) contoured the point data using a triangulated irregular network method (quad level = 15) from the SPANS geographic information system (GIS) whereas Maathuis (1999) contoured the AVI values using minimum curvature method.

The AVI method is based on two physical parameters:

1. thickness (d) of each sedimentary layer above an aquifer
2. estimated vertical hydraulic conductivity (K_v) of the sedimentary layer

The thickness of the confining layer is obtained from past drilling records and/or by testhole data. Hydraulic conducitivity was assigned to each sedimentary unit based on typical values by Freeze and Cherry (1979). Table 1 lists the range of hydraulic conductivities for sediments in the Prairie Provinces.

Sediment Type	Standard Code	Hydraulic Conducitivity (m/day)
Gravel	A	1000*
Sand	B	10*
Silty sand	C	1*
Silt	D	10^{-1*}
Fractured till, clay or shale (0 to 5 m from ground surface)	E	10^{-3**}
Fractured till, clay or shale (5 to 10 m from ground surface)	F	10^{4*}
Fractured till, clay or shale (10 m from ground surface, but weathered based on colour; brown or yellow)	F	10^{-4*}
Massive till or mixed sand-silt-clay	G	10^{-5*}
Massive clay or shale	H	10^{-6*}

Table 1. Estimated hydraulic conductivity (Van Stempvoort et al., 1993).
*estimate based on Freeze and Cherry (1993)
**estimate based on Keller et al. (1988).

The resultant AVI values represent areas of different resistance, which can be grouped into a qualitative index shown in Table 1.

Hydraulic Resistance (c) (years)	Log (c)	Vulnerability (AVI)
0 to 10	<1	Extremely High
10 to 100	1 to 2	High
100 to 1000	2 to 3	Moderate
1000 to 10000	3 to 4	Low
>10000	>4	Extremely Low

Table 2. Relationship between hydraulic resistance and the aquifer vulnerability index.

Several assumptions and limitations exist in the AVI method. Detailed descriptions of the limitations of the AVI method are given in Van Stempvoort et al. (1993). Listed are few examples of the limitations of the method:

- Certain parameters are not considered in the method such as climate, hydraulic gradient, porosity, topography, and water content of the porous media.
- Data quality from the water well drillers records included in the database vary considerably in detail and information between water well contractors.
- The AVI method considers only nearest to surface aquifers, and considers each aquifer to be of equal value. It does not distinguish between surficial and bedrock aquifers or multi-layered aquifer-aquitard sequences.

- The AVI method does not consider water quality. Many near-surface aquifers have naturally high concentrations of dissolved ions.
- The hydraulic conductivity (K) of various sediment types are estimated resulting in a range of hydraulic resistance.
- The method does not consider lateral continuity or discontinuity of aquifers. Continuous regions should not be interpreted as one aquifer but may be composed of several or two or more vertically overlapping vulnerable aquifers.

Aquifer vulnerability maps should be considered as a preliminary tool for identifying areas of susceptibility of at or near-surface contamination. The maps are based on regional scale geological or soil data and should not be used for site-specific locations.

Regulated Use of Groundwater

Domestic water wells in Saskatchewan require regulatory approval. However, non-domestic water wells in Saskatchewan require regulatory approval from the Saskatchewan Watershed Authority. Regulation of groundwater works is administered through the *Saskatchewan Watershed Authority Act* and *The Ground Water Conservation Act*. Approval of any groundwater works are required to ensure the proposed project are sustainable and do not cause adverse impacts to existing users or the environment. Examples of works requiring an approval include municipal, industrial, (including groundwater de-watering), intensive livestock operations, and irrigation.

iv. Chemical Container disposal areas and landfill operations are point sources of pollution that can affect surface and groundwater quality. These operations must be properly managed and enforced.

- Meetings with the Advisory Committees indicated that there is a general lack of knowledge in the rural communities about the proper disposal procedures for chemical containers.

Landfill Sites and Operations

Municipal landfills have existed since the beginning of the built history of Saskatchewan. The number of "municipal" type landfills would have originally coincided with the number of settlements located along the waterways, trails and eventually railways and highways as the Territory developed into a network of established communities and formed the Province of Saskatchewan.

Landfills were frequently sited out of convenience and cost savings, on unused, non-agricultural, inexpensive land with little knowledge or consideration of environmental impacts. Common locations for landfill sites were sloughs, gravel extraction pits, gullies, coulees, or land with alkaline or sandy soils, all of which are generally unsuitable for the intended use. Due to steep topography, high water tables, moving water, poor drainage and soil types found at landfill locations and/or the lack of machinery or funds, waste was simply tipped and, if combustible, burned with little or no further maintenance.

Originally, many of the wastes delivered to landfills were ashes from burning barrels or unburnable household items such as metal, glass and pottery. Burnable materials delivered to the landfill sites were burned on site and waste was rarely buried. Separation of waste was unheard of and liquid wastes such as sewage, oil and solvents were mixed with solid waste at the sites.

Changes occurred in the socio-economic background of the province during the 1940's from a primarily low-tech agricultural society to a diversified high-tech agricultural society. A shift to additional manufacturing and service industry activity caused massive changes in the types and volumes of waste handled at landfills. Packaging waste increased as goods were transported from around the world, requiring packaging for transport. Shifts away from the use of bulk items increased the amount of packaging waste to be handled. Today's extensive use of plastics and other synthetically originated packaging materials which can produce a whole range of toxins when burned, or have a long life when buried at the landfill, have caused the need for changes in the management of municipal solid waste and the methods to safely and economically operate municipal waste disposal grounds.

As the burning of household waste in burning barrels became an unacceptable practice in most urban centres, very large volumes of waste began to arrive at landfill sites which were not only poorly sited, but much too limited in capacity to handle the waste. Burning of the waste at the landfills to reduce volumes, control litter and deter pests, became very common. This became not only an air quality hazard and a nuisance to residents who lived near the landfills, but a major fire hazard and a potential threat to surface and groundwater in the vicinities of the landfills. Poorly managed landfills, commonly referred to as “nuisance grounds” or “junk yards”, became harbourage for vermin such as rats. Wind blown paper and light plastics became eyesores, serving as hazards to animals grazing adjacent to landfills and clogging farm machinery.

The 1970's and the new regulations brought improved siting of new landfills and some separation of waste materials at landfills. The main materials separated for recycling at IPSCO in Regina were junked vehicles and other metals through the “Operation Recycle” program. Scrap tires and rubble were being stockpiled and spoiled grain/grain cleanings and dead animals were treated separately at some sites.

Through the 1980's and 1990's separation of other materials for storage, treatment or special disposal has increased over the years to include empty pesticide containers, trees/lumber, petroleum contaminated soils, compost, dead animals, biomedical waste, treated grain, shingles, waste oil storage and paper/cardboard storage. Waste dangerous goods are only accepted at landfills under special circumstances on a per time basis. The disposal of sewage is not allowed at waste disposal grounds. Today, large volumes of municipal waste (beverage and milk containers) are diverted from disposal through SARCAN.

Paper and cardboard recycling opportunities exist in many larger communities. Tire and waste oil stewardship programs are removing two of the more challenging waste streams from entering landfills.

Evaluation of a Proposed Landfill Site

When the site selection process is underway or nearing completion, an engineering consultant needs to provide the necessary technical evaluations. Steps to be completed are:

- review possible site locations identified by the community, assessing size and location;
- a technical evaluation including a geotechnical and hydrogeotechnical evaluation including installing piezomenters and determining baseline information;
- review of the area information (well records, land uses, etc.);
- topographic mapping of the area;
- surface drainage review;
- monitoring requirements of existing and proposed sites;
- design and operation of proposed site including the site decommissioning;
- an operational guideline for the site operation; and
- a technical evaluation for closure or decommissioning of the old (existing) site.

Technical review to ensure:

- legislative requirements have been met;
- all environmental issues have been raised and dealt with;
- and all public concerns have been addressed.

Issuance of a Permit to Establish, Operate and Maintain a Waste Disposal Ground

Permit is issued outlining the construction requirements recommended in the consultant's report. The permit includes:

- the location of the site;
- the operation and maintenance required at the site;
- and the monitoring and reporting requirements.

Draft Guideline for the Closure and Reclamation of Municipal Waste Disposal Grounds, October 1998

A draft guideline has been developed to ensure closure and reclamation of a landfill is done in an environmentally and aesthetically acceptable manner and considering long-term protection of the environment and the possible re-use of the land.

The following are excerpts from the guidelines:

> Prior to 1972, waste disposal ground development, management and operation was the sole responsibility of the urban and rural municipalities. The *Waste Management Regulations* under *The Public Health Act* were enacted in 1972 to provide a consistent approach to waste management throughout the province. Saskatchewan Environment and Resource Management (SERM) provided technical backup to Saskatchewan Health after 1972. In 1984, the responsibility for waste disposal grounds was transferred to SERM. The *Municipal Refuse Management Regulations* (MRMR) were enacted under *The Environmental Management and Protection Act* in 1986 to deal with the establishment, operation, maintenance and closure of a waste disposal ground. These regulations have not undergone any changes since 1986.

The long-term nature of a landfill and the changing of legislative powers have resulted in a number of scenarios for landfills:

1. A number of landfills in the province were developed before there were regulations governing landfills.
2. Other landfills were sited between 1972 and 1986 when Saskatchewan Health's regulations were the legislative authority.

   NOTE: Both of these types of sites do not have a valid permit unless the owner requested one under the current legislation or upgraded their facility since 1986.
3. Landfills developed since 1986 are required to have a permit under MRMR.

For landfills that do not have a permit under the current regulations, the closure requirements of the regulations are only recommendations. Although these sites do not have a permit, it is in the best interest of the communities to follow the current environmental requirements to ensure the environmental risks are minimized and the environmental liability of the owner is reduced.

Communities that hold a Permit to Operate under the regulations are required to follow the closure and reclamation conditions established by SERM and pursuant to Section 13 of *The Municipal Refuse Management Regulations*

SERM's philosophies on risk assessment are being applied to the closure and reclamation for waste disposal grounds. The risk assessment goal is to ensure the evaluation, monitoring and remediation of a site are based on the risk the site poses to the environment. This guideline separates the sites of different risks by a classification system, with a Class C site being a low risk site with little potential of impacting the environment to a Class A site that has a high potential for or has already impacted the environment.

For further details please review the complete SE document.

UARB Study Information

The Dillon Report prepared for the Upper Assiniboine River Basin Study states:

There are also over 80 landfills, many of which have been operating for decades and do not necessarily meet today's environmental standards for such operations (Betcher et al., 1995). For example, some have sloughs on site and others are situated in areas with high water tables and/or coarse soils. These conditions create opportunities for ground water contamination from the variety of hazardous wastes these sites may contain (SERM data). Maathuis (1991) has identified an old landfill at 36-25-04-W2 as a potential source of contamination of the Logan Aquifer.

The ability for point source sites to contaminate local ground and surface waters is dependant upon the nature of the contaminant, design of the facility, and the site-specific environmental considerations (CCME, 1994). A knowledge of how various chemical and associated components persist and mobilize is critical in determining the risk that they pose to water quality. Site-specific characteristics are also factors in water contamination. Soil type can influence leaching potential and topography can influence the rate of runoff (EPA, 1976). Ground water close to the surface in an area with porous soils is at higher risk than sites with heavy clay and deep ground water (WCWWA, 1994).

The Saskatchewan guidelines stipulate that:

- The site must be located more than 500 m from a surface water body, and situated on soils with a high clay content.
- Runoff must be contained, and ground water recharge areas avoided. Approval is to be obtained from Saskatchewan Environment and Resource Management.
- Saskatchewan began operating these sites prior to implementation of the guidelines outlined above.

- Thus, container storage areas built before the guidelines may not adequately protect surface and ground water quality (Pupp et al., 1991).

Chemical Containers

Several years ago the pesticide manufacturing industry took full control of the pesticide container collection program. They felt they could offer a more efficient service to their customers and better control the costs associated with recycling pesticide containers. To accomplish this, the industry went away from the unsupervised municipal collection sites to a system of dealer collection points.

Producers can contact their local RM office to find their nearest dealer collection site. They should be able to dispose of their old unwanted pesticide containers at the dealer site.

- If producers have any questions or if they require additional information, they can contact Mr. Richard Wilkins of the Environmental Protection Branch, SE, by phone at 787-0466 or by e-mail at rwilkins@serm.gov.sk.ca

The Dillon Report prepared for the UARB Study states:

Other potential sources of concern are pesticide container storage sites scattered throughout the Assiniboine Basin. These sites are used to store used agricultural containers.

In Saskatchewan, there are two programs presently in place that deal with the collection of empty agricultural chemical containers. Many pesticide collection sites are operated by local rural municipalities. Some of these sites have been closed and new sites established that are operated by suppliers of the pesticides. Prior to returning empty agricultural chemical containers farmers are required to clean, triple rinse, and properly drain the containers. The empty containers are collected from the sites by the end of each crop year. The first program began in 1982, and was referred to as the "Pesticide Container Management Program." Saskatchewan Environment and Resource Management (SERM) provided funding for initial start-up of the sites, developed extensive siting criteria, and conducted site inspections. However, the day-to-day operations and maintenance of the program was the responsibility of the local municipality (Appendix IV).

The second program, "Voluntary Container Collection Program," began operation at the start of the 1999 crop season. It is co-ordinated by the Saskatchewan Pesticide Container Management Association Inc., in conjunction with the Crop Protection Institute. Crop protection distribution companies and their participating retail dealers are voluntary participants in the program. Once collected, the empty, clean containers are transported to a central location for shredding. The shredded plastic is shipped to recycling plants for the manufacture of products such as curb stops and fence posts.

These two programs do not deal with unwanted and unused chemical product. Within Saskatchewan, *The Pest Control Products (Saskatchewan) Act* regulates the improper use, storage, disposal, or abandonment of agricultural chemicals and containers. Local environment offices should be notified if chemicals/chemical containers are improperly used or discarded.

Agricultural Chemical Container Collection Depots

Table 5.1 (Saskatchewan only) and Figure 5.5 (map) identify the agricultural chemical container collection depots in the Basin. Excluded from the table, are the container collection sites established through dealer participation within the Upper Assiniboine River Basin (Saskatchewan only). These dealer sites were only established over the last two years and include the following locations: Kamsack (Pioneer Grain Co.), Rama (Rama Co-op Associatio Ltd.), Rhein (Imperial Oil), Yorkton (Cropmate - UAP, Imperial Oil, Parrish and Heinbecker Ltd.). The municipal sites are being gradually closed in preference to the dealer sites.

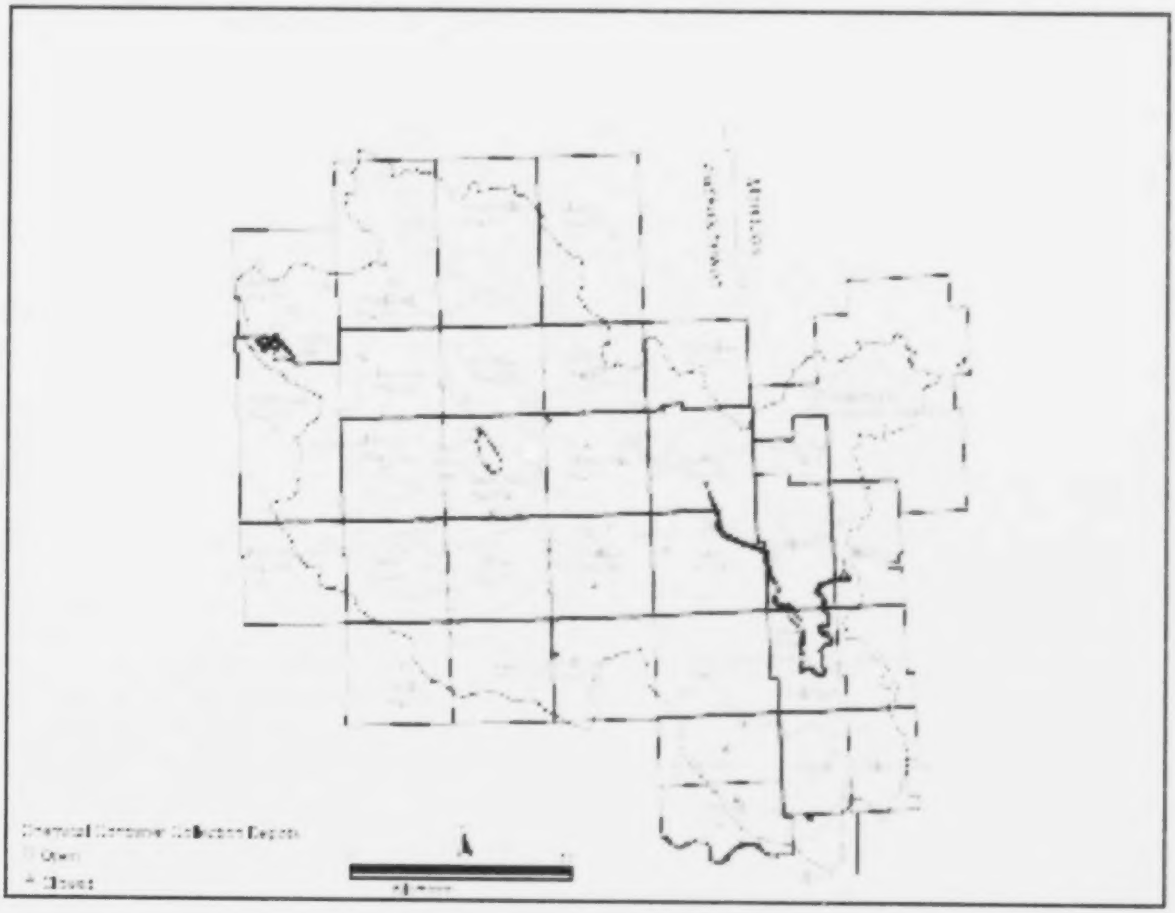
Agricultural Pesticide Collection Sites

In early spring 1999, the "Saskatchewan Pesticide Return Program" was initiated for the collection and disposal of unwanted, and obsolete agricultural pesticides. In 1999, only the southern part of the Province participated. In 2000, central Saskatchewan is being targeted and Basin residents south of Hwy No. 16 can participate. In 2001, the program will cover areas north of Hwy No. 16. The program focuses on the collection of pesticides only. Products such as antifreeze, solvents, paints, and other hazardous wastes will not be accepted.

Table 5.1
Municipal Agricultural Chemical Container Collection Depots in Saskatchewan

Rural Municipality	Land Location (portion, Section, Township, Range, Meridian)
Spy Hill, No. 152	SW 16-18-32 W1
Spy Hill, No. 152 **- discontinued site**	**NW 30-19-31 W1**
Spy Hill, No. 152 **- discontinued site**	**SE 22-19-31 W1**
Langenburg, No. 181	SE 04-21-31 W1
Langenburg, No. 181 **- discontinued site**	**SW 04-21-31 W1**
Langenburg, No. 181 **- discontinued site**	**SE 25-21-31 W1**
Fertile Belt, No.183	SW 35-18-01 W2
Churchbridge, No. 211	SE 29-22-32 W1
Saltcoats, No. 213	SW 04-23-02 W2
Cana, No. 214	SW 15-23-05 W2
Stanley, No. 215	SE 27-23-05 W2
Calder, No. 241	NW 17-25-31 W1
Calder, No. 241	SE 31-26-32 W1
Wallace, No. 243	SW 20-27-02 W2
Wallace, No. 243 **- discontinued site**	**NE 32-25-02 W2**
Orkney, No. 244	SE 26-27-02 W2
Garry, No. 245	NE 02-27-05 W2
Ituna Bon Accord, No. 246	NW 03-26-12 W2
Cote, No. 271	NW 27-29-32 W1
Sliding Hills, No. 273	SE 10-30-01 W2
Sliding Hills, No. 273 **- discontinued site**	**SW 05-30-02 W2**
Good Lake, No. 274	SW 19-25-05 W2
Good Lake, No. 274 **- discontinued site**	**NW 24-25-05 W2**
Good Lake, No. 274	SE 15-30-04 W2
Good Lake, No. 274 **- discontinued site**	**NW 04-25-05 W2**
Insinger, No. 275	NE 20-29-05 W2
Foam Lake, No. 276	SE 30-30-11 W2
Keys, No. 303	NW 18-32-02 W2
Buchanan, No. 304	SW 35-31-06 W2
Invermay, No. 305	SW 11-33-09 W2
Clayton, No. 333	NW 20-36-01 W2
Preeceville, No. 334	SE 03-35-05 W2
Hazel Dell, No. 335	SE 15-35-05 W2
Hazel Dell, No. 335 **- discontinued site**	**NE 33-35-05 W2**
Sasman, No. 336	NW 11-35-10 W2
Sasman, No. 336	NE 22-34-11 W2
Sasman, No. 336	SW 02-36-12 W2

Figure 5.5
Location of Municipal Agricultural Collection Depot in the Basin


Chemical Container Collection Depots
Open
Closed

v. **Agricultural runoff may contain increased sediment, nutrients and pesticides. Agricultural drainage from farm land, sloughs and wetlands can be a non point source of pollution of surface water.**

a) Agricultural runoff may contain increased sediment, nutrients and pesticides.

- Prepared by Brian Campbell and Rob Kirkness

Sask Ag provided the following information for the Assiniboine Background Report:

> The Assiniboine watershed lies in east central Saskatchewan. There are approximately 23 rural municipalities in whole, or in part, located in the watershed, which is well serviced by road and rail. Yorkton is the regional centre for trade. The trading area population of Yorkton (150 km radius) is 111,193. Much of this is based on agricultural trade. The city has a well developed infrastructure including service by rail and highway. It has hospitals, schools, regional colleges for training and other services essential to sustain population growth. There are around 10 smaller but important trading centres in the watershed with a good agriculture and urban business base.
>
> Located in an area of diverse soil types, ranging from black soil to dark gray and grey soil, the watershed is situated in the aspen parkland region. Blessed with adequate precipitation, the area was one of the few in western Canada to miss the droughts of '88-'89 and '01-'02. Farming operations are diverse including: crop production, registered seed production with on-farm processing, fruit production (strawberries, saskatoons, and sea buckthorn), maple syrup production and potato production. There are also organic producer groups in the area (in excess of 100) and many more producer groups working toward organic certification. With some areas of the watershed having marginal cropland and good moisture, agro-forestry has become a viable option.
>
> On an RM basis, the 2001 Land in Crops map shows that the average number of cropped acres per RM is 105,000 – 140,000 acres. There are a few pockets with a higher proportion of land committed to crop production but the larger proportion of the land appears to be used for pasture. The use of summerfallow remains considerable in the watershed although this practice has significantly decreased over the last decade (2001 Land in Summerfallow).
>
> Crop production in the region can be defined as conventional with the majority of crops produced in the watershed being exported for processing. The opportunities for growth in this sector appear to lie with the organic sector and the seed processing industry. For the seed processing industry

it is perhaps reasonable, given the crop production numbers, to consider the development of additional seed processing facilities in the area. Along with the increase in interest and production, there is a need for increased technical information.

Many producers in the watershed have been organic growers for some time. There is an incentive to enter this sector based on increasing costs of commercial inputs and the willingness of consumers to pay premium prices for the products. The Organic Crop Improvement Association (OCIA) Chapter 6 and the Saskatchewan Organic Certification Association (SOCA) have over one hundred members.

Three experts met with the Assiniboine Technical Committee as part of the Issues Analysis process. Presentations were made followed by discussions and questions.

A. Juanita Poleigi from the Saskatchewan Soil Conservation Association

The key messages from Juanita's presentation were:

- Direct seeding acres in Sask have increased from about 3,000,000 acres in 1990 to approximately 14,000,000 acres in 2001 and a projected 35,000,000 acres for 2008

- Direct Seeding is summarized as:

    - no pre-working of the soil prior to seeding,
    - low disturbance seed boots
    - use herbicides prior to seeding, in-crop, pre-harvest and post harvest
    - no summer fallow, and continuous cropping

- Benefits of direct seeding

    - Increases water infiltration
    - Increases water holding capacity of the soil
    - Improves seed bed moisture in the spring
    - Reduced soil erosion
    - Increased organic matter
    - Reduced operating costs
    - Environmentally friendly - reduces greenhouse gas emissions
    - no-till soils are more biologically active and diverse

- Direct seeding process relies extensively on the use of glyphosate (Roundup). Strategic use of other herbicides is also needed.

- Roundup is a systemic pesticide that, when translocated throughout the plant, inhibits the production of some aromatic amino acids essential for plant growth.
- The major natural metabolite in plant and soil is aminomethylphosphonic acid (AMPA).
- Soil microbes further breakdown AMPA to carbon dioxide, inorganic phosphate, and other naturally occurring compounds.
- The parent acid of glyphosate has a negative charge, and salts with a positive charge are formulated with glyphosate to produce a finished product.
- Breakdown in soil and groundwater:
  Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days
- It is strongly adsorbed to most soils, even those with lower organic and clay content.
- Even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter
- One estimate indicated that less than 2% of the applied chemical is lost to runoff.
- Microbes are primarily responsible for the breakdown of the product.
- Its half-life in pond water ranges from 12 days to 10 weeks.

B. Ken Panchuk is the Provincial Soils Specialist from Sask Ag, Food and Rural Revitalization, Regina

Key messages from Ken's presentation were:

- Soils within the Assiniboine River basin are 'basic' (pH>7.0) and have a high concentration of Calcium. This results with the fixation of P by Calcium within the soil profile. Thus P is not very mobile. pH & calcium concentrations generally increase with depth, further preventing downward movement of phosphorus.

- Top dressing P for annual crop production is not practiced in Saskatchewan. It is estimated that approximately **80% of fertilizer is applied by banding**. This percentage is increasing in direct relationship to increased adoption of direct seeding practices.

- Urea is the main N fertilizer product used in Saskatchewan and will continue to be the main product for the foreseeable future. Urea and anhydrous ammonia convert to ammonium (a positive charged molecule that adsorbs to negatively charged clay and soil organic matter). Ammonium is not mobile in soil as compared to nitrate-N that is a mobile nutrient.

- **"Harvest the water"** is a focus to 'use up' as much of the available water possible in the rooting zone each year because water is the most important yield limiting factor in Saskatchewan dryland crop and forage production. Using the water from the rooting zone to grow crops and forage greatly decreases the potential of water movement (both surface runoff and downward leaching) and associated nutrient and soil movement.

- Water is one 'engine' that drives the movement of nutrients and soil. Soil movement by wind erosion is by far a bigger risk than the water erosion process. This is part of the reason for why there is a high adoption of direct seeding.

- Major hydrologic events like high rainfall events and flooding do happen and can move soil and nutrients. We need to be prepared for such events by adopting management practices that will minimize the risk of soil and nutrient movement.

- Direct seeding, no till, min till are great ways to minimize soil erosion (and thus reduce the risk of phosphorus movement with runoff water). When the topsoil erodes with water or wind it also takes the nutrient rich soil organic matter with it so reducing the risk of soil erosion remains a priority.

- need to "Balance the nutrients based on soil testing" to optimize biomass production and 'water use'

- 'annually soil testing is an important tool for optimizing crop and forage production while minimizing environmental risk

- The 'wording' is significant here. Crop and forage production are not maximized (bushels/acre or tons/acre) as a rule with fertilizer. The greatest return in $$$/acre is maximized using the soil test results as one of several tools.

C. Cameron Wilk is the Provincial Pesticide Specialist from Sask Agriculture, located in Regina

Cameron's Key messages were as follows:

- Before a pesticide is allowed to be used or sold in Canada, it must undergo a rigorous scientific assessment process to ensure it does not pose unacceptable risks to human health or the environment

- Provincial/Territorial governments are responsible for regulating the sale, use, storage, transportation and disposal of federally registered pesticides.

- In 1995, the PMRA, in conjunction with the provinces and territories, released the Standard for Pesticide Education, Training and Certification in Canada for implementation across the country.

- Most applications are by licensed applicators . . . and most producers utilize custom operators

- A modern scientific approach to examining older active ingredients and their end-uses to determine their continuing acceptability in relation to human health and the environment. Is resulting in many products being de licensed

- 84% of all sales are Herbicides

- 95.8% of all sales are Sold into Agriculture

- Of the 352 commercial or agricultural pesticide products available to Saskatchewan producers 56 of those comprise the majority of the sales.

    - 219 are herbicides of which 34 are commonly sold
    - 58 seed treatments of which 3 are commonly sold
    - 24 foliar fungicides of which 3 commonly sold
    - 51 insecticides of which 2 are commonly sold

- the most used herbicides are:

    - glyphosate (630,000 litres), 2-4, D (29,,000 liters), and bromoxynil are the most prevalent herbicides;
    - glyphosate most used by far

- the most prevalent insecticides are:

    - chlorpyrifos (128,000 litres) and deltamethrin (Decis)

- the most prevalent foliar fungicides are:

    - Chlorothalonil (Bravo), azoxystrobin (Quadris) (7827 litres) and propiconazole (Tilt).

Environmental Fate was also reviewed:

Glyphosate or Roundup

- Glyphosate is the most commonly used herbicide
- It is s moderately persistent in soil, with an estimated average half-life of 47 days
- It is strongly adsorbed to most soils, even those with lower organic and clay content.
- Even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter
- One estimate indicated that less than 2% of the applied chemical is lost to runoff.
- Microbes are primarily responsible for the breakdown of the product.
- **Breakdown in water:** In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms. Its half-life in pond water ranges from 12 days to 10 weeks .

Chlorpyrifos

- Chlorpyrifos is the most commonly used insecticide
- When applied to moist soils, the volatility half-life of chlorpyrifos was 45 to 163 hours, with 62 to 89% of the applied chlorpyrifos remaining on the soil after 36 hours
- Chlorpyrifos adsorbs strongly to soil particles and it is not readily soluble in water
- It is therefore immobile in soils and unlikely to leach or to contaminate groundwater.
- Chlorpyrifos adheres to sediments and suspended organic matter, concentrations rapidly decline.
- Volatilization is probably the primary route of loss of chlorpyrifos from water. Volatility half-lives of 3.5 and 20 days have been estimated for pond water

Riparian Buffer Strips

Buffers strips or zones keep sediments and associated nutrients and pesticides away from waterways.

Buffers function based on the premise of decreasing the velocity of water, which results in the settling out of suspended soil particles and enhancing the infiltration of water born nutrients, contained in the runoff, within the buffer. Buffers also effectively trap fertilizers, pesticides, pathogens and heavy metals. If they are properly installed and maintained, they have the capacity to:

- remove up to 50 percent or more of nutrients and pesticides

- remove up to 60 percent of certain pathogens
- remove up to 75 percent or more of sediments

To maximize the benefits of buffers it is recommended that they are combined with other conservation practices, such as zero till or minimum tillage.

Since most of our runoff occurs in the spring, the practice of retaining stubble over winter on fields, at least those adjacent to waterways, would be advantageous.

Benefit	**Vegetation Type**		
	Grass	**Shrub**	**Tree**
Stabilize bank erosion	low	high	high
Filter Sediment	high	low	low
Filter nutrients, pesticides, microbes			
sediment bound	high	low	low
soluble	medium	low	medium
Aquatic Habitat	low	medium	high
Wildlife Habitat			
range/pasture/prairie wildlife	high	medium	low
forest wildlife	low	medium	high
Economic products	medium	low	medium
Visual diversity	low	medium	high
Flood protection	low	medium	high

Concluding thoughts on cropping

- Cropping is a major land use in the Assiniboine watershed.

- 30 years of water quality data for the Assiniboine River near Kamsack, indicate no significant changes and there are no apparent imminent disasters waiting to occur.

- The trend is for farms to become larger. This means bigger equipment and larger land bases. This trend seems ‘economically warranted’. In addition the larger operations have increased financial resources for better equipment (meaning more accurate), more frequent soil testing, improved application of nutrients, pesticides etc

- Cropping is an extremely variable environment, with many unpredictable factors. There is no one simple process to follow along to guarantee success and or predictable outcomes.

b) Agricultural drainage from farm land, sloughs and wetlands can be a non point source of pollution of surface water.

The drainage of wetlands for conversion to farmland was examined in great detail as part of the Upper Assiniboine River Basin Study. The following are offered as summary points with respect to source water protection.

- Non-point contamination from agricultural runoff is a concern in the Upper Assiniboine River Basin. Sediment levels are generally higher in runoff from agricultural land than from natural areas. Nutrients, in the form of either manure or artificial fertilizers, may bind to sediment or dissolve in runoff water. Pesticides from cropland may also move with runoff water.

- Minimizing water-borne contamination from agricultural land would satisfy environmental concerns and the interests of landowners. The appropriate application of fertilizers and pesticides is key to reducing contamination from agricultural runoff.

- There is consensus that wetlands are extremely important for many types of wildlife. However, for wetlands, the relationship between wetlands and water quality, the benefits are not as profound. The contribution of wetlands to enhance and protect water quality may vary greatly between wetland types, wetland position within the watershed etc. For example, a pristine pothole wetland located in a natural parkland setting may provide minimal water quality benefit to an adjacent stream. However, when a farmer creates a poorly-designed drain the receiving stream's water quality may suffer from resulting erosion and siltation.

- Wetlands that are directly within the stream and or river corridors are of extreme value and benefit to source water protection.

- The relative volume of runoff entering a wetland with respect to the water capacity volume of the wetland is another variable to consider. The lower the ratio, the more that the wetland acts as a reservoir and is able to 'slow' the movement of runoff through it, thereby accumulating and trapping sediments.

- The relationship between wetlands and groundwater is also not consistent. In some situations a wetland is extremely important to local shallow aquifers. However, in areas of heavy clay soils where the aquifer is located far below the surface, the relationship is not as easily apparent.

- It was concluded that wetlands and uplands in the Assiniboine watershed are important and should be protected. The continual removal and degradation of the uplands associated with wetlands and riparian areas will place the watershed health at risk.

- Wildlife and wildlife habitat can be ideal indicators of ecosystem health, and the ability of a watershed to provide a sustainable source of quality water for human use. In addition, wetlands are instrumental to a healthy watershed.

- Planning should identify wetland areas and land parcels which should not be developed for agricultural use due to their higher value for other purposes.

- Proper planning of agricultural drainage projects is necessary to reduce channel erosion. In addition planning should retain or establish riparian buffers to filter the water entering the drainage system. As part of the project planning, economic and environmental justification should be considered, with avoidance examined as an option.

- Drainage works should incorporate their existing natural elements to the greatest extent as possible, such as wetlands and existing riparian vegetation.

- Mitigation of lost aquatic habitat may be an option. Mitigation may involve retaining, improving or restoring habitat to compensate for habitat that may be lost in developing a project that involves land drainage and or clearing. This concept is applicable at both small scale (individual farm) and a larger scale proposal (watershed level).

vi. Algal blooms on Lake of the Prairies are a concern.

- ***Prepared by Jim Rogers . . . Environment Canada***

Lake of the Prairies is located at the confluence of the Assiniboine and Shell Rivers and extends north westerly across the Manitoba border into Saskatchewan. The Dam was originally built in 1969 to provide downstream flood protection and to provide a consistent water supply for municipal, industrial and irrigation users. The reservoir is very productive and supports an excellent sport fishery that generates estimated revenues of just over 2 million dollars (1990 survey census).

Manitoba Water Stewardship and PFRA are conducting investigations to determine the feasibility of raising the storage capacity of the reservoir to sustain any future increased water supply demands by downstream users. Issues with past upstream flooding have been addressed and agreements are in place for purchase of lands in the upstream reaches. The evaluation of the different options for installing gates at the control structure is currently underway. Manitoba Water Stewardship has also formed an instream flow working group to address the instream flow needs of the Assiniboine River necessary to support and maintain a healthy biological community. In addition a linked study of three distinct segments (Lake of the Prairies to Brandon, Brandon to Portage, and Portage to Winnipeg) is ongoing. Information obtained from these studies will be used to develop a water quality model that will be used by managers to determine the total loadings allowable to sustain present and future uses of the Assiniboine River.

Mercury concentrations in fish tissue have been monitored at Lake of the Prairies annually since 1982. Overall mercury concentrations measured during the past ten years have fluctuated but are consistently lower than concentrations measured in the 1980's. Caution must be still exercised when consuming predatory species such as walleye, as larger individuals may still have mercury concentrations above the 0.05 ppm consumption guideline.

Algal blooms continue to develop during the summer months potentially impacting the aesthetic and recreational uses of the lake. Often, the algae blooms are composed of blue green algae species capable of producing toxins. Associated with these blooms is the potential impact on dissolved oxygen concentrations should a rapid algal die-off occur. A 1998 Water Stewardship report titled "*Phosphorous Loading to Shellmouth Reservoir, Manitoba , Canada*" determined that high nutrient levels within the reservoir, particularly phosphorous sustained blooms within the reservoir. The report indicated that internal loading from the sediments was one of the main nutrient sources. It is anticipated that, similar to other jurisdictions, reducing the external loading to the reservoir will result in a lag time before the benefits become evident due to internal recycling of nutrients. Nevertheless, Manitoba Water Stewardship is committed to reducing nutrient loading throughout the province including Lake of the Prairies as part of its overall Nutrient Management Strategy and Lake Winnipeg Action Plan. It would be beneficial when developing the Upper Assiniboine River watershed plan, that consideration is given to implementing plans and practices to reducing nutrient loading within the watershed.

vii. Livestock operations and range management practices deteriorate water quality and impact downstream users.

- ***Prepared by Brian Campbell and Rob Kirkness***

Sask Ag provided the following information for the Assiniboine Background Report

Saskatchewan's livestock industry is expanding and is expected to continue expanding in the future. On Saskatchewan farms there are:

- 1.43 million cows
- 1.25 million hogs
- 21.5 million chickens, 0.7 million turkeys, 1.0 million layers
- Specialty livestock such as sheep, goats, etc…

Families are migrating from other provinces and other countries because Saskatchewan is an attractive place to raise livestock. Rural Saskatchewan features a very low population density within large blocks of fertile land. SAFRR is involved in the following initiatives to attract people to Saskatchewan for livestock production:

- Saskatchewan Immigrant Nominee Program
- "The Last Cattle Frontier"

The expanding livestock industry is regulated by *The Agricultural Operations Act*. The act requires designated livestock operations to operate according to approved manure storage and manure management plans for assurance of water protection.

Manure

Manure handling differs by species, and this affects potential watershed impact. The following table is an overview of typical manure management by species.

	Animal Housing	Manure Type	Application Frequency	Application method	Manure Storage
Poultry	Barn	Solid	6 x / year	Surface	In barn
Hogs	Barn	Liquid	2 x / year	Injection	EMS (earthen manure storage)
Dairy	Barn / pasture	Liquid	2 x / year	Surface	EMS / tank
Beef	Pens / pasture	Solid	2 x / year	Surface	Holding pond

When animals are housed indoors, precipitation is prevented from reaching manure thus preventing migration of contaminants to a water source. When animals are confined outdoors, holding ponds often exist to prevent runoff from the facilities reaching watercourses. Injected liquid manure has little opportunity for movement because it is placed below the ground surface. Nitrogen in solid manure is organically bound; solid manure takes many years to decompose to water-soluble nitrogen.

Manure injection is an effective way to apply manure to farmland. Saskatchewan researchers were instrumental in developing this technology with funding assistance from the Agricultural Development Fund (ADF). With the exception of some small producers, hog operations use manure injection exclusively. Application rates are agronomically balanced (based on nitrogen) to expected crop requirements. A typical liquid manure injection rate is equivalent to a 0.5 inch rainfall event.

Regulations

The Agricultural Operations Act is administered by the Agricultural Operations section of SAFRR. The Agricultural Operations program features:

- Approval of manure storage plans
- Approval of manure management plans
- Approval of mortality management plans
- Special conditions of approval for increased water protection
- Re-inspection of approved operations
- Investigation of alleged pollution from intensive livestock operations
- Site characterization for determining environmentally secure sites

Agricultural Operations has recently developed site characterization guidelines to assist livestock developers select suitable sites for earthen manure storage. Much of Saskatchewan is underlain by glacial till that is an effective material to securely contain manure. The guidelines help identify locations with suitable material and sufficient separation to potential receptors to ensure protection of groundwater. The guidelines are based on a solute transport model developed by Dr. Lee Barbour of the University of Saskatchewan.

Livestock

Specialty Livestock

There are a number of producers in the area growing specialty livestock. This includes bison, elk, deer and wild boar. While some of this is sold farm gate, there is currently one producer that has branded their product and is marketing under a product brand.

Long range plans have been affected by the BSE crisis of May 2004 but the opportunity remains, especially for Bison.

Dairy

There are a number of dairies in the watershed (see Dairy Producers map). The average dairy herd (on milk recording systems) is about 109 head as opposed to an average herd size of 50 head 10 years ago. The number of dairies in the watershed has decreased significantly over the past decade.

Beef: Cow-Calf

The Assiniboine Watershed is well suited for expansion of the cow-calf sector. Cattle operations (2001 Total Cattle and Calves Map) vary in size throughout the watershed. About 1/3 of the RMs average 6,000 – 9,000 head, 1/3 of the RMs average 9,000 – 12,000 head and a handful of RMs (211, 244 & 334) average 15,000 – 18,000 head. According to SAFRR district reports, current cow-calf numbers for the watershed would be approximately 100,000 head. With the elimination of the Crow benefit, this area has some of the highest freight rates for shipping grain. This has resulted in land prices remaining low when compared to comparable land in other areas. Over the past 5 years a number of new operators from Alberta have moved into the area, bringing their livestock with them. Interest expressed by established and new producers in expanding their herd would indicate an average increase of 15% over the next several years. Business options of cow-calf cooperatives or partnerships have been considered. This may prove beneficial to the feedlot industry as it expands by providing a more standard calf to meet market demand.

Increases in forage production to support an increased cow-calf herd have been occurring. The watershed is naturally well suited to extensive grazing.

Beef: Feedlots

The majority of calves produced in the watershed are moved out of the area for finishing. In addition, a large amount of feed barley is shipped out of the area. There are a few small feedlots (<500 head) and several larger scale facilities. The map of Intensive Beef Operations shows cattle operations (over 300 animal units) that have received approval under *The Agricultural Operations Act.* It should be noted that some of these may no longer be operating. Communities have initiated discussion for new feedlot proposals but have not actively pursued the idea since the BSE crisis of May 2004.

Identification of reliable water sources and consistent feed supplies are critical to increasing feedlot capacities in the watershed.

Poultry

The watershed has a number of broiler chicken producers and approximately half of the turkey production in Saskatchewan. Three new broiler operations have moved into the area over the last several years. The area provides good access to the only poultry processor in Saskatchewan at Wynyard.

Hogs

Hog production has traditionally been a small component of the livestock industry along the eastern side of the province. A 2400 sow farrow to finish operation and a 5000 sow farrow to finish operation have been developed in the watershed within the last five years. The geographic location of the watershed with its access to abundant feed provides opportunities for increasing hog numbers. Several communities continue to explore the option of establishing a large hog project in their area and it is likely that these opportunities will continue to be pursued.

Some established meat processors in the watershed have been discussing the possibility of increasing capacity and this may also provide an incentive for increased hog production.

Dr. Jeff Schoenau of the Department of Soil Science at the University of Saskatchewan is a technical expert on manure and its application to soils. He met with the Assiniboine Advisory and Technical Committee as part of the Issues Analysis process. A presentation was made followed by discussions and questions.

The key messages from Dr. Schoenau's presentation were:

Key messages

- Manure is a resource that should be treated as a fertilizer (N,P,K,S, Micronutrients)
- It can also be a soil builder, especially solid manures
- Must know the nutrient make up of the manure by testing, and then may have to balance the nutrients needed by adding a commercial fertilizer.
- Liquid effluents have high availability of nutrients in first year of application, and not much organics
- Solid manures have slow availability of nutrients, lots of organics.
- Select an application rate that matches crop demand and nutrient removal over time
- Determine an appropriate rate using manure testing and soil testing
- Get the manure into the ground
- Ensure a proper ratio of available nutrients in soil, following manure application

- If apply too much manure, then can end up with excess nutrient loading.
- On well-drained soils, the effects of manure application on soil salinity are minimized and flush below root zone. Soils should be monitored over time for salinity.

Information on Stream Corridors

The stream corridor is the transition zone between the river and the adjacent uplands. It forms *the backbone of a watershed ecosystem*. The corridor normally consists of the valley form, adjacent vegetation and significant natural areas. The stream channel, valley walls, floodplain (comprised of a variety of native species of vegetation) and wetlands are aspects which help define the corridor boundaries. Each component has specific functions that are essential to the health of the stream and riparian zone. The stream corridor is a key element within the hydrologic cycle.

Values of a Healthy Stream Corridor:

- transporting of nutrients to aquatic habitats downstream
- during large runoff events, floodplains provide flood storage to reduce downstream flooding
- during floods, rivers and streams deposit sediments within the floodplain which enriches the soils within the floodplain
- the stream corridor, with its native vegetation, purifies surface runoff from adjacent uplands by filtering out sediments, absorbing nutrients within the root zone, and tying up and/or altering harmful contaminants
- the floodplain can also provide local groundwater recharge that is later released as a source of cold clear water
- the stream corridor provides habitat for various aquatic and terrestrial species
- the corridor provide a source of food, cover, travel corridors between adjoining habitats, and reproductive habitat for aquatic and terrestrial species
- from a social perspective they provide benefits for education, aesthetics and a variety of recreation opportunities such as fishing, bird watching, canoeing etc.
- livestock forage and good quality water

Concluding thoughts on livestock

- Intensive livestock operations include both hogs and cattle.

- The biggest concern raised and most often raised is manure mgmt. Odour is often raised, even though it is not related to water quality. Hog operations have a more negative connotation than cattle.
- Bigger operations seems to imply less water quality impact since there are better regulations, better controls, and generally better management
- The trend is towards larger operations (largely because of economics) and the so called ma & pa operators will fade away
- New livestock operations are tightly scrutinized and regulated
- Must be careful with manure storage and application with respect to wells, especially abandoned wells. Proper citing plus good well integrity practices are important.

Concluding thoughts on Pasture operations

- The biggest water quality aspect seems to be access to riparian zones
- No agricultural regulations apply to this aspect. However, there is DFO's deleterious impacts
- Erosion is a major concern, both streambank/streambed degradation
- Large cattle grazing operations are focussed on good grass management which implies better situations for riparian zones
- Good quality drinking water is critical for optimum livestock weight gain
- Worst case scenario in the Assiniboine River Watershed, is a mixed farming operation, focussed on grain production. In this scenario, cattle are often fenced in small paddocks encompassing riparian areas for the whole summer. This results in major riparian impacts.
- The Trend is also towards larger operations and thus the smaller 'ma & pa' operators will fade away

viii. Municipal lagoon operations, sewage treatment and effluent disposal can impact water quality and must be strictly managed.

Introduction

Throughout the various watershed drainage regions that make up the Upper Assiniboine River Basin there are 26 towns and villages that operate licensed multi-celled lagoons as part of their wastewater treatment system (Dillon Consulting Limited, 1998). These systems utilize the forces of nature to treat the effluent and are designed to provide the minimal amount of treatment required by the province of Saskatchewan for towns and small villages.

- The various licenses for these systems allow for the discharge of the lagoons once or twice yearly into the local watercourse. While many of the towns do not discharge their treated effluent directly into the Assiniboine River, all drainage from this area eventually drains into the river.
- The City of Yorkton has a more advanced mechanical wastewater treatment system, which treats the effluent on a continuous basis allowing for continuous discharge to the river.

The province has discharge objectives and regulations that control the construction, operation, and pollution control mechanisms for lagoons. Operating licence/permits for each individual project are designed to protect the receiving water bodies from contamination or pollution. While the requirements of each licence/permit varies, each requirement is specific to the local situation and takes into account the mixing zone of the receiving body of water, flows present, and the time of year.

Since there are a number of sewage treatment facilities within this drainage area, river water quality could be a major concern to the Basin and downstream water bodies due to accumulation of nutrients such as nitrogen and phosphorous. It is these nutrients that accumulate in the water bodies and act as fertilizers and encourage algal growth. The accumulation of nutrients in the various water bodies is of concern as it can lead to a decrease in water quality and eutrophication of the lakes over the long-term.

Sludge and liquid effluent from municipal and agricultural waste contain trace metals. Land applications can redistribute these in the aquatic environment where they can be transferred through the food chain. Some are highly mobile and can leach into groundwater or runoff (EPA, 1976). Others accumulate in surface soils where runoff can transfer trace metals to surface water bodies via eroded soils (USCATST, 1992; EPA, 1976).

Municipal Wastewater

Municipal wastewater comes from our homes, businesses, and industries. It carries the wastes of daily living, such as water from showers, toilets, laundry, dishwashers, and business operations. Municipal wastewater is usually gray in colour and most often has a musty odour.

- Wastewater is approximately 99.9 percent water, with the remaining 0.1 percent being solids.
- Almost half (40 percent) of these solids are dissolved solids - they are dissolved in the wastewater much like salt is dissolved in sea water.
- The rest of the solids are suspended solids.

Lagoons are shallow ponds that utilize components of nature such as sunlight, algae, microorganisms, and oxygen to interact and treat or stabilize the wastewater. They are designed to provide secondary treatment, the minimal amount of treatment required by the province of Saskatchewan for towns and small villages. Although lagoon construction can cost in excess of $100,000 they are relatively inexpensive compared to more advanced systems, have minimal operating costs, and are simpler to operate.

Wastewater Treatment/Lagoons

Within the Upper Assiniboine River Basin, two processes for wastewater treatment are found, utilizing a system of at least two ponds or cells, referred to as lagoons. Many larger lagoon systems may contain several treatment and storage cells.

When wastewater is treated properly, many suspended and dissolved pollutants are removed and the effluent can be released safely to the environment. There are three types of lagoon treatment cells used in Saskatchewan: facultative lagoons, aerated lagoons, and anaerobic lagoons.

1) Facultative Lagoons have an aerobic (containing oxygen) surface layer and an anaerobic (without oxygen) bottom layer. Facultative lagoons are the most common type with approximately 500 in Saskatchewan.

    - All the lagoons located within the Assiniboine River Basin are a facultative treatment cell design.

2) Aerated Lagoons add oxygen artificially to the wastewater with various types of aeration devices, and they can treat wastewater in a smaller treatment cell. However, they do require a power input. Aerated lagoons tend to be smaller and deeper than facultative lagoons.

3) Anaerobic Lagoons operate without any dissolved oxygen. Wastewater treatment is provided by anaerobic microorganisms that can thrive without dissolved oxygen. These lagoons are smaller but deeper than the facultative type.

Treatment

1) Primary Treatment

Involves the physical removal of the solid materials in the wastewater that readily settle out by gravity, and takes place in the first cell, called the treatment or primary cell.

2) Secondary Treatment

Purifies wastewater by removing organic materials through biological processes, and takes place in the secondary cell. It is also referred to as the storage cell because it stores the wastewater between releases into the environment. Processes within the secondary cell utilize microorganisms (bacteria and other small organisms) to consume organics such as fats, carbohydrates, and proteins that are dissolved in the wastewater.

- **Aerobic** microorganisms use oxygen and give off carbon dioxide as they consume the organic "food" during secondary treatment.
- **Anaerobic** microorganisms also use this food source, but they do not use oxygen, and they give off gases such as methane and hydrogen sulphide.

Legislation

Within the Province of Saskatchewan, lagoon construction and operation are subject to The Water Pollution Control and Water Works Regulations (WPC and WWRs) of *The Environmental Management and Protection Act* (EMPA), as well as *The Water Corporation Act* (WCA). The highlights of the legislation include:

- Construction or alteration of a lagoon requires approval by Sask Water (WCA).
- A permit is required for wastewater disposal from Saskatchewan Environment and Resource Management (EMPA).
- Treated wastewater must meet requirements set by the Minister of Environment and Resource Management (EMPA).
- A minimum of secondary wastewater treatment or use of facultative lagoons is required in Saskatchewan (WPC and WWRs).
- Facultative lagoons must have a minimum of two cells operating in series - one after the other (WPC and WWRs).

- A minimum size for primary cells is specified (WPC and WWRs).
- Lagoons cannot be discharged between November 1 and spring runoff (WPC and WWRs).
- Tests must be done and records maintained as required by the Minister of Environment and Resource Management (WPC and WWRs).

Sask Environment approves wastewater treatment facility construction applications and issues a permit to operate. Applications are then reviewed for approval of health and environmental elements, and to issue a permit for the sewage works. This permit sets out the required testing and record keeping, and identifies any limits that the treatment facility may be required to meet.

Private wastewater treatment and disposal, which occurs where there is no municipal collection system, is subject to regulations and permitting administered by Saskatchewan Health. In the case of small commercial developments, (i.e., small motels, trailer courts and small restaurants, etc.),

- where the wastewater flow rate is less than 18 cubic metres (4,000 gallons) per day, the construction of wastewater treatment and disposal facilities requires approval from Sask Environment, and is subject to regulations and permitting administered by Saskatchewan Health.

During an emergency situation a permit may be amended to reflect actual operating circumstances. For example, recent years of excessive rainfall have resulted in emergency discharge of effluent from some systems which incorporate evaporation cells. In such an event, samples are taken prior to discharge and have shown to be suitable for release to the environment since the effluent primarily consists of rainwater. There are also some communities, although allowed to discharge twice a year that do not discharge at all. This may be due to decreasing population, minimal snow and rain moisture or drought like conditions causing excessive evaporation.

Factors Affecting Wastewater Treatment in Lagoons

Many natural factors affect how well lagoons work in treating wastewater. Ideal conditions for lagoon treatment occur during the long, warm, sunny days of summer, when a moderate breeze is blowing.

1) Wind Action - wind mixes the wastewater and adds the oxygen necessary for aerobic microorganisms to do their work.

2) Temperature - affects how much oxygen the wastewater can hold and determines how quickly the microorganisms will act to break down the organic materials in the wastewater. Treatment occurs most quickly when temperatures are high.

3) Sunlight - causes algae to grow in the lagoon. Algae, like other plants, give off oxygen as they grow. Aerobic microorganisms use this oxygen as they break down dissolved materials in the wastewater. These processes also help to destroy disease-causing bacteria.

4) Winter - treatment also occurs during the winter months when solids settle out in the treatment cell and anaerobic bacteria break down organic pollutants. Due to colder temperatures and lack of natural aeration and sunlight, winter treatment is not as effective as treatment during the other seasons.

5) Unwanted Waste - although lagoon treatment systems can cope with most normal waste products, consumers are discouraged from disposing of wastes such as battery acid, solvents, paints, waste oil products, and other toxic or hazardous wastes into their municipal sewer systems.

Facility Operation, Maintenance, and Monitoring

Release of Wastewater

Adequately sized and properly operated lagoon systems provide treatment that meets provincial objectives. Treated wastewater from the lagoon storage cells may be released according to their licence specifications but generally occurs twice a year. The first release typically occurs during the spring runoff, the second during the fall - usually in late October.

Within the Upper Assiniboine River Basin,

- 11 communities discharge treated wastewater directly into watercourses such as the Assiniboine River;

- 7 communities discharge treated wastewater into localized water bodies, such as sloughs or small lakes;

- three communities utilize alternative disposal methods, such as effluent irrigation; and,

- 5 communities do not discharge wastewater as there is enough evaporation during the summer.

During the spring release, wastewater treated in the lagoon and stored over the winter is discharged and mixes with the runoff from melting snow. In the fall release, wastewater treated and stored over the summer is discharged from the lagoon. After each release, the discharge valve from the storage cell is closed, and a valve between the treatment storage cells is opened briefly to "equalize" the cells. This prevents drying out of the cells after the spring release and freezing of the piping after the fall release.

Lagoons may be discharged into dry or flowing creek beds, rivers, sloughs, ditches, fields, pastures, and sometimes lakes. Communities must have agreements with landowners to allow for disposal of treated wastewater to private land.

Wastewater as a Resource

Saskatchewan Environment encourages the use of treated wastewater as a resource. For example, it can be used for irrigating crop land, a process known as effluent irrigation. Treated wastewater is often suitable for use in wetlands projects for rearing waterfowl.

Solids

The solid material that settles to the bottom of the lagoon is called sludge or bio-solids. Most of the bio-solids are decomposed by microorganisms in the lagoon. It is seldom necessary to remove the few bio-solids that remain. When removal does become necessary, these solids may be spread on nearby farmland, where they serve as a source of nutrients for crop growth. Communities should contact their local environment department representatives for guidelines prior to bio-solid disposal.

Odour

Odour is not normally a significant problem around lagoons. However, lagoons that are too small to serve a community's population sometimes have odour problems. Also, for a short period of time in the spring immediately after the ice melts, it is normal for lagoon systems to experience temporary odorous conditions. Gases such as hydrogen sulphide given off by anaerobic bacteria as they treat the wastewater under the ice will cause odours in the spring.

Permits/Licenses

In Saskatchewan, each community's wastewater treatment system is issued a permit that outlines how many samples must be collected by the community, where the samples must be taken from, how the samples must be analyzed, and which operating records must be kept.

Usually three samples are required. The first sample is taken upstream from the point of discharge, the second sample at the point of discharge, and the third sample is taken downstream from the point of discharge. The second and third samples are taken halfway through the discharge process. Samples are analyzed for the following parameters:

- total kjeldahl nitrogen;
- nitrate nitrogen;
- total phosphorous;
- total suspended solids;
- volatile suspended solids;
- dissolved organic carbon;
- 5-day 20/ Celsius biochemical oxygen demand;
- total coliform bacteria;
- fecal coliform bacteria;
- conductivity at 25/ Celsius;
- pH;
- alkalinity;
- calcium;
- magnesium;
- potassium;
- sodium;
- bicarbonate;
- carbonate;
- chloride;
- and sulphate.

Communities take samples to find out how well the lagoon treatment system is working and what effects the discharges are having on water quality in the receiving environment. The data obtained from sampling are primarily used as an indication of how well a system is working. Operating records would include dates of effluent discharges and the quantity of effluent discharged.

The following Table lists expected effluent quality produced by well operated treatment facilities that treat typical municipal sanitary sewage.

Sewage Treatment Processes - Typical Effluent Quality

Process	BOD mg/L	TSS mg/L	Total-P mg/L	Total-N mg/L	Total Coliforms 100 mL
Primary:					
- incl. anaerobic lagoons	75-150	50-110	5-7	25-45	2x10[illegible]
- with phosphorous removal	45-55	25-50	1-2	20-40	2x10[illegible]
Secondary:					
- biological (Mech.)	10-25	10-25	5.5-6.5	15-35	2x10[illegible]-2x10[illegible]
- aerated Lagoons	15-30	20-35	4-7	20-40	2x10[illegible]-2x10[illegible]
- aerobic Lagoons					
Spring	25-70	20-60	3.5-7	20-35	2x10[illegible]-2x10[illegible]
Late Fall	10-30	10-40	2-5	5-20	2x10[illegible]-2x10[illegible]
Advanced:					
- secondary with chemical treatment (phosphorous control)	36660	36828	0.5-1.5	15-35	2x10[illegible]-2x10[illegible]

* levels required by SERM for communities within the Saskatchewan portion of the Basin.

Environmental Impacts

Although properly constructed and operated lagoons generally provide high quality wastewater treatment, environmental impacts can occur when treated wastewater is released. For example:

- Bacteria may render downstream water unfit for drinking water supply, irrigation, or recreation uses.
- Minerals in the wastewater can affect the use of the receiving water for irrigation or livestock watering.
- Available nutrients such as phosphorous from a lagoon discharge may promote excessive growth of algae and weeds in waterways.
- Discharges of ammonia from a lagoon may be harmful to aquatic life, including fish because of the toxicity of the unionized ammonia form.
- Increased colour and turbidity (cloudy water) can impair the physical appearance of downstream water for some uses.
- Seepage (leakage) from lagoons can result in damage to land or groundwater.

Current Municipal Lagoons in the Basin

All population figures are taken from the Saskatchewan Municipal Affairs, Culture and Housing 1999 Municipal Directory.

1) Buchanan

   - Population 279, located at SE 4-31-06-W2, 2 cell system, allowed to discharge twice a year into Good Spirit Creek.

2) Calder

- Population 106, located at NE 15-25-31-W1, 2 cell system, allowed to discharge twice a year into Calder Lake.

3) Canora

- Population 2,208, located at NE 31-30-03-W2, 2 cell system, allowed to discharge twice a year into Whitesand River.

4) Churchbridge

- Population 815, located at SE 18-22-32-W1 and NW 08-22-32-W1, 2 cell system, allowed to discharge twice a year into Deerhorn Creek.

5) Duck Mountain Provincial Park

- Population unknown (seasonal), located at N ½ 21-30- 30-W1 (Ministik/Core area), 2 cell system, allowed to discharge twice a year into marsh area located at NE 21-30-30-W1. Another lagoon is located at NW 13-31-30-W1 (Pickeral Point), 2 cell system, allowed to discharge into a surface drainage in the NW 13-31-30-W1.

6) Ebenezer

- Population 166, located SW 25-27-04-W2, 2 cell system. Strictly an evaporation system which does not discharge unless in an emergency.

7) Good Spirit Provincial Park

- Population unknown (seasonal), located at E 1/28-29-5-W2, 2 cell system. Primarily an evaporation system, however, also allowed to utilize effluent irrigation as a method of disposal if needed.

8) Hyas

- Population 119, located at NE 06-34-02-W2, 2 cell system, allowed to discharge twice a year into a nearby slough.

9) Invermay

- Population 295, located at NW 01-33-09-W2, 2 cell system, allowed to discharge twice a year into Saline Lake.

10) Jedburgh

- Population 13, located at NE 36-26-08-W2, 2 cell system that doesn't discharge.

11) Kamsack

- Population 2,264, located at NE 27-29-32-W1, 2 cell system, allowed to discharge twice a year into Assiniboine River.

12) Langenburg

- Population 1,119, located at NE 26-21-31-W1, 2 cell system, allowed to discharge twice a year into Smith Creek.

13) MacNutt

- Population 95, located at SE 22-24-31-W1, 2 cell system, intermittent discharge.

14) Margo

- Population 127, located at NW 10-33-10-W2, 2 cell system, discharges into Margo Lake.

15) Melville

- Population 4,646, located at NE 04-23-06-W2, a 4 cell system, allowed to discharge twice a year into Crescent Creek. Also allowed to utilize effluent irrigation to the golf course.

16) Preeceville

- Population 1,148, located at SE 27-34-05-W2, 2 cell system, allowed to discharge twice a year into the Assiniboine River.

17) Rama

- Population 99, located at SW 24-32-08-W2, 1 cell system, discharges into slough on village property.

18) Rhein

- Population 197, located at SW 26-27-2-W2, 2 cell system, allowed to discharge twice a year into slough on same location

19) Saltcoats

- Population 531, located at NW 36-23-02-W2, 2 cell system, allowed to discharge twice a year into natural drainage course.

20) Sheho

- Population 181, located at NW 10-30-09-W2, 2 cell system, allowed to discharge twice a year into Elbow Creek.

21) Spy Hill

- Population 264, located at NE 02-19-31-W1, 2 cell system, allowed to discharge twice a year into Deerhorn Creek.

22) Stenen

- Population 100, located at SE 09-34-03-W1, anerobic 2 small treatment cells, allowed to discharge twice a year.

23) Sturgis

- Population 684, located at NW 21-34-04-W2, 2 cell system, allowed to discharge twice a year into the Assiniboine River.

24) Theodore

- Population 434, located at SW 15-28-07-W2, 2 cell system, allowed to discharge twice a year into Theodore Lake (slough).

25) Togo

- Population 138, located at NE 02-28-30-W1, 2 cell system which doesn't discharge.

26) Veregin

- Population 90, located at SW 10-30-01-W2, 2 cell system, doesn't discharge.

27) Wroxton

- Population 50, located at NW 03-26-32-W1, 2 cell system, doesn't discharge.

28) Yorkton

- Population 15,154, Mechanical treatment system, constant discharge into Yorkton Creek

Lagoon Reviews

In late 2004, Sask Environment initiated a review process of all wastewater lagoons in the Province of Saskatchewan.

The majority of the wastewater facilities have been inspected in the province and re-licensing of all the wastewater facilities has commenced. As part of the licensing process a relative risk rating system (risk assessments) for wastewater treatment and disposal facilities has been developed and is being completed prior to issuance of draft permits for the operation of wastewater works.

The majority of the wastewater risk assessments was to be completed by end of the 2005 fiscal year.

First Nations

To assess the status of water and wastewater systems of First Nations communities across Canada, Indian and Northern Affairs (INAC) undertook a comprehensive onsite assessment of on-reserve water and wastewater treatment facilities. A report, **"National Assessment of Water & Wastewater Systems in First Nations Communities Summary Report"** was prepared in 2003 by INAC.

The assessment considered performance, operating practices, operator qualifications, defined quality objectives and identified areas of improvement and the required costs.

Wastewater Facilities were assigned a risk category from high, medium, and low depending on repair need or potential risk. INAC is working with the Bands to develop strategies to deal with the high and medium risk facilities first.

In the Assiniboine Basin, no First Nations wastewater facilities were in the high risk category.

Mechanical Wastewater Treatment Plants

Mechanical wastewater treatment plants consist of arrangements of mechanical devices and structures that treat wastewater within a matter of hours. They can be fairly compact and are thus suitable for larger centres. Although mechanical treatment systems require less space than lagoons, they are expensive to build and operate.

The H.M. Bailey Water Pollution Control Plant in Yorkton, commissioned in 1991, is the only mechanical treatment plant in the Assiniboine River Basin. The plant discharges treated wastewater on a daily basis; therefore, more diligent monitoring of the effluent and the receiving stream is required (see Table 6.2). Table 6.3 provides the mean seasonal water quality results for three monitoring stations on Yorkton Creek;

Station 1:

- 1 mile upstream of the discharge;

Station 2:

- 1 mile downstream of the discharge; and,

Station 3:

- 10 miles downstream.

The monitoring was done by the City of Yorkton during the period 1992 to 1999 as a requirement of the City's permit to operate sewage works. The parameters used in Table 6.1 are significant when assessing the impacts of a municipal wastewater discharge. Overall, the H.M. Bailey Plant met the requirements as specified by the province (Table 6.1) for secondary sewage treatment at a mechanical treatment plant.

As shown in Table 6.3, total coliform and fecal coliform counts at Station 1 ranged from 840 to 25,432 organisms per 100mL, and 64 to 458 organisms per 100 mL, respectively. The relatively high counts during summer at this station may be due to contamination from livestock operations or other sources.

The total and fecal coliform counts increased dramatically at Station 2, as would be expected just below a wastewater discharge. However, by the time the effluent reached Station 3 there was a significant die-off of these bacteria to levels at least 90 percent less than measured at Station 2.

Data presented in Table 2.4 for the Whitesand River indicate that this dieoff continued downstream to where coliform counts ranged from only 10 to 40 organisms per 100 mL at Highway No. 9. These counts were well below the surface water quality objectives for both contact and non-contact recreation.

The data for nutrient loadings from Table 6.3 indicate that the concentration of total nitrogen, total phosphorus, ammonia-nitrogen and nitrate-nitrogen downstream of the discharge are lowest in spring and highest in winter. Again, this is expected since nutrient concentrations are typically affected by the quantity of water flow in the system, with lower concentrations in spring and higher concentrations in winter under ice. The data also indicate that lower concentrations of nitrate-nitrogen and higher concentrations of ammonia-nitrogen during winter may be due to anaerobic conditions and conversion of nitrate to ammonia.

Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Effluent of the Yorkton Sewage Treatment Plant

Parameters	Spring	Summer	Fall	Winter
Fecal Coliforms	24268	57029	159994	119912
Total Coliforms	118533	334830	255361	422870
NO_3NO_2	2.82	7.6	8.75	3.02
Ammonia	23.2	12.93	14.16	24.55
TKN	28.8	14.5	16.5	31.6
BOD	16.4	25.2	23.0	23.75
Total P	4.53	3.99	5.77	6.25
Ortho-P	3.69	2.93	4.57	4.99
Sodium	344.8	307.6	350.5	336.9
Sulphate	445.1	563.3	511.3	426.5
TDS	2108	2204	2159	2195
TSS	11.9	13.5	11.6	13.7

Expressed in mg/L

Water Quality Results from 1992 to 1999 Presented as a Seasonal Average for Yorkton Creek, Upstream and Downstream of the Yorkton Sewage Treatment Plant

Parameters	1.6 km upstream STP				1.6 km downstream STP				West of Ebenezer (16.1 km north of Yorkton)			
	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter
Fecal Coliforms	64	493	80		7276	16198	5311	199205	361	94	40	7303
Total Coliforms	11251	25432	840		43393	334041	330717	377750	1211	6556	1211	48471
NO_3NO_2	0.536	0.048	0.13		1.75	-	5.6	2.6	0.77	0.8675	2.1	1.45
Ammonia	0.82	0.06	0.19		2.48	5.37	11.4	24.9	0.675	0.53	1.51	19.27
TKN	3.16	2	2.41		4.98	8.53	10.95	31.5	3.04	2.64	6.01	37.17
BOD	7.01	3.1	2.48		9.15	12.7	8.5	12.6	6.3	3.86	5.25	9.2
Total P	0.6	0.2	0.19		2.4	2.14	3.69	6.59	0.85	1.28	1.55	7.5
Ortho-P	0.38	0.11	0.09		0.47	1.84	2.92	5.33	0.57	1.03	1.24	6.9
Sodium	55	76	94		61	201	252	403	117	148	234	472
Sulphate	133.5	302	387		152	462	473	399	191	353.6	445	481
TDS	514	925	107		571	1622	1777	2191	827	1221	1323	2300
TSS	20.7	7.6	10.3		24.3	10.5	15.1	11.6	20.9	18.1	20.5	14.9

Expressed in mg/L

ix. Rural residents have expressed concerns that "Urban Stormwater Runoff" may be adversely affecting the water quality of streams and rivers downstream of the larger communities in the Assiniboine River basin.

- ***Prepared by Rob Kirkness . . . SWA***

Snowmelt and rainfall events that occur in urban areas results in surface runoff, termed 'urban stormwater runoff'. It is transported by stormwater sewers and drainage channels to streams and rivers, downstream of these communities. As the runoff travels across and through the urban area it becomes degraded by a variety of contaminants. Examples of these are: suspended solids, chloride, petroleum products, trace metals, fertilizers, pesticides, herbicides, pathogens, microorganisms. Urban runoff has been recognized to cause significant environmental impacts for the past 30 years. This runoff can exceed the volumes of releases from wastewater treatments and also exceed the suspended solids loading.

These can result in the deterioration on the water quality of the streams and rivers receiving the urban stormwater runoff. In addition there can be a negative impact on aquatic life of these waters. All components of the aquatic ecosystems can be affected. Impacts on water quality and aquatic habitats will also be subjected to cumulative affects.

In addition to being a potential source of contaminants, stormwater flow characteristics can be rapid pulses, or short duration high intensity flows. This in turn can cause erosion and streambank stability issues.

Urban stormwater is not specifically regulated by any jurisdiction. In Saskatchewan, exemptions for Urban Stormwater were removed when "The Water Pollution Control and Waterworks Regulations" were revised in Dec 2002, becoming The Water Regulations, 2002.

Sask Environment is presently developing a Stormwater Management "best practices" document. The goal is to have the document drafted by the end of the fiscal year. The next step would be to initiate an internal government review, followed by a public review. This should occur in August or September 2005.

Urban development within the Assiniboine River watershed is relatively limited, with the City of Yorkton being the largest centre with a population of 17,000 and a land area of about 15.0 sq km. The City of Melville, the next largest centre, has a population of 4,650 and a land area of 15.4 sq km. This is in comparison to the Assiniboine watershed area within Saskatchewan of approximately 16,590 sq km.

Even though the urban element is relatively small in size, the impact of urban runoff may be adversely affecting stream reaches in the stream areas downstream of the larger centres in the basin.

The water quality of stormwater is highly variable within a runoff event, from event to event and year to year. It is known that the quality is poorest at the beginning of an event and improves over the duration of the event.

There is limited scientific data available on stormwater runoff for urban centres in Saskatchewan. It is apparent that there is an information gap on this aspect, especially for smaller cities such as Yorkton.

The Watershed Authority and the City of Yorkton have agreed to jointly conduct a pilot project at the City of Yorkton on stormwater runoff. Samples will be collected to determine what contaminants are contained in the City's runoff and to also determine the relative magnitude of the various constituents.

x. **Flooding was raised as an issue in that there may be specific situations where development is occurring within the flood plain which may result in potential contamination of source waters.**

- No specific information was prepared for this section
- Various examples such as development of well sites within a flood plain could result in aquifer contamination, waste water facilities (private, municipal, agricultural) within the flood plain could be major sources of contaminants to surface water, were discussed during technical meetings

B. Watershed Health Related

xi. **The economic and social considerations associated with wetlands and agriculture should be better understood.**

xii. **Wetlands and uplands in the Basin are important and should be protected. The continued removal and degradation of the uplands associated with wetlands and riparian areas will place wildlife at risk.**

- ***Prepared by Doug Brook . . . Ducks Unlimited***

Wetlands, riparian habitats and upland habitats are important natural landscape features that contribute to source water protection and watershed health.

Conserving these features through sound and sustainable land use practices provides a multi-barrier approach to protecting source waters.

Wetlands

The UARB Study estimated that approximately 95 percent of the wetland drainage in the basin is unauthorized. The cumulative impact of a large number of unauthorized drainage projects is significant since the cumulative storage volume becomes more significant as you move downstream and non-contributing areas now contribute to the runoff.

UARB Study states that an average of 81 percent of the wetland area has been impacted by drainage (p.112) with the majority of temporary wetlands completely cultivated (p.118). These impacted areas no longer provide the many source water protection benefits and in fact can contribute to negative to water quality and quantity impacts due to drainage associated activities.

Currently 70 percent of all seasonal and 20 percent of all temporary wetlands are cultivated in the basin. Traditionally, loss of these seasonal and temporary wetlands was considered insignificant as long as permanent wetlands were protected. We now have a better understanding on the role these small, less permanent wetlands play in maintaining an healthy watershed and they need to be included in any wetland protection or mitigation policies. A greater understanding on the definition of wetland types and their role is required to clarify the extent of negative impacts.

The hydrological functions of wetlands include storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows, de-synchronization of flood peaks, and erosion prevention. The ability of a wetland to attenuate floodwater is influenced by position in the landscape, location of the water table, soil permeability, slope, and moisture conditions. Wetland drainage reduces the capability of a watershed to attenuate runoff during flood conditions. Maintaining and restoring wetlands on the landscape reduces overland flow rates and therefore potential flooding.

Recharge of groundwater is an extremely important function of some wetlands; water percolates slowly from wetlands to aquifers. Interactions between wetlands and local or regional groundwater supplies are complex and site-specific and affected by the position of the wetland with respect to groundwater flow systems, geologic characteristics of the substrate, and climate.

Although not all wetlands directly recharge groundwater aquifers due to their location, size or type, their role in source water protection is just as important. The numerous small wetlands found throughout the Upper Assiniboine River watershed, can be effective nitrate sinks in agricultural landscapes (over 80% removal). Phosphorus retention in wetlands can also be significant (up to 94%)

and is accomplished through adsorption onto particles, precipitation with metals and incorporation into living biomass. Removal of these wetlands through drainage activities or filling in not only remove their ability to store runoff in small events, but allow the sediment and potential contaminants that would normally be contained in them to pass downstream into larger wetlands or streams where recharge of aquifers does occur or water is drawn directly withdrawn for human or livestock consumption.

Additional and more detailed information on the role wetlands play in source water protection are available in the following documents:

> "**NATURAL VALUES**, The Importance of Wetlands & Upland Conservation Practices in Watershed Management: Functions & Values for Water Quality and Quantity", Ducks Unlimited Canada - http://www.ducks.ca/conserve/wetland_values/pdf/nvalue.pdf
>
> "**The Role of Canadian Wetlands for Improving Water Quality**, A review of the biological and economic values wetlands provide to society and environment" by Lisette Ross, Ducks Unlimited Canada

Riparian Buffers

Vegetated buffer strips can effectively control erosion by forming a physical barrier that slows the surface flow of sediment and debris, by stabilizing wetland edges and stream banks, and by promoting infiltration. The required width of a buffer size is determined by the type of vegetation present; the extent and impact of the adjacent land use; and the functional value of the receiving wetland or watercourse. Studies have found the bulk of sediment removal occurs in the first few meters of the buffer zone; sediment removal can be 75-97%.

Buffer strips can effectively remove nutrients from surface water flow. The main mechanisms of nitrate removal are by vegetation uptake in the roots and anaerobic microbial denitrification in the saturated zone of the soil. Relatively narrow buffers seem to be very (35-96%) effective in reducing nitrogen.

Phosphorus removal can be effective (27-97%) in buffer strips that contain both woody and herbaceous vegetation, grasses and cropped buffer systems. Buffer strips can trap a significant proportion of pathogens (up to 74% of fecal coliforms); however, remaining levels often exceed minimum drinking water standards. Low soil moisture and high soil temperature substantially decrease survival of total and fecal coliform bacteria. The key process for pesticide retention in buffer strips is infiltration. Grass buffer strips can reduce pesticides by 8-100%.

Upland Cover

Upland conservation programs, such as no-till and permanent perennial cover, slow surface runoff, trap sediments and promote infiltration, consequently reducing the amount of sediments, nutrients and pesticides that enter the watershed.

One of the most beneficial outcome from implementing practices such as conservation tillage and permanent perennial cover is erosion reduction. Erosion from wind, rain and runoff can be reduced up to 99% because of greater site stability, infiltration and protection as a result of surface crop residue and perennial vegetation.

Upland cover has shown to be effective in reducing the amounts of nitrogen (up to 90%), phosphorus (up to 91%) and pesticides (up to 100%) in runoff but there is potential for increased leaching through the soil profile to groundwater. Although conservation tillage has not always reduced nutrient and pesticide leaching, this practice is recommended because the benefits outweigh the potential drawbacks. With respect to perennial upland cover, this land has been removed from production, resulting in fewer pesticides and fertilizer nutrients applied and subsequently released. Currently there is insufficient information regarding upland conservation practices and pathogen movement.

Other Benefits Wetlands and Upland Cover

In addition to source water protection benefits, natural land features provide a variety of ecological goods and services to society at large, to the wildlife resource, and to the landowner. They are valuable emergency supplies of forage in times of drought and can serve as important domestic water supplies for people and livestock.

A healthy landscape that has been designed for source water protection will also provide suitable habitat for wildlife. In fact, wildlife population health provides an indicator of landscape health and the ability to provide quality water. There is a direct link and a landscape that is being altered and degraded through the removal of wildlife habitat is less capable of providing the many benefits to humans as well as wildlife.

xiii. Land and water management practices are affecting fish habitat.

- ***Prepared by Rick Orr . . . DFO***

Description of the issue

Fish habitat may be affected directly or indirectly by land and water management practices. Practices that affect fish habitat typically also affect water quantity and quality for use by humans. Conversely, measures taken to protect fish habitat also provide protection of water quantity and quality for human use.

Direct research concerning the impacts of land and water management practices on fish habitat has not been conducted in Saskatchewan. However, the relationship of land use to fish habitat health was investigated for 103 small watersheds in Wisconsin (Wang et al. 1997), a landscape similar to Saskatchewan. Habitat quality showed strong relationships to land use in this survey. Some relationships of relevance to the Assiniboine watershed include:

- Streams with more forest land in the watershed had higher habitat quality.
- Habitat quality in streams was not affected by agriculture when less than 50% of the watershed was in agricultural land. When more than 50% of the watershed was agricultural land, stream habitat quality decreased as the area used for agriculture increased.
- Stream habitat quality in agricultural watersheds was related to the degree of development in a 100 meter buffer along the stream.
- For warm water streams (i.e., non-trout streams) habitat quality was greater for watersheds with more wetlands.

Land and water management practices that affect fish habitat, stream flow patterns and water quality in the Assiniboine River watershed include water storage works, drainage of wetlands and farm land, stream channelization, land clearing for agricultural crops, grazing, and road development.

Water storage works affect fish habitat and water quality in a variety of ways. On the positive side, water impoundments may provide good quality habitat for use by fish on seasonal streams that would not otherwise support permanent fish populations. However, dams also have many negative impacts (Baxter and Glaude 1980). Dams create impassable barriers to fish thereby preventing migrating fish from reaching spawning areas resulting in significant impacts to their populations. Fluctuating water levels in reservoirs can prevent formation of aquatic vegetation in near shore areas with impacts to fish spawning, rearing and overall productivity. Fluctuating water levels also encourage shoreline erosion leading to sediment being deposited on fish habitat with harmful consequences. Erosion also damages water quality by increasing suspended sediment loads. Flooding of terrestrial habitat following dam construction elevates mercury levels with impacts to the edibility of fish. Leaching of nutrients from flooded land also affects water quality and encourages excessive algal growth in the impoundment. Dams disrupt the natural flow regimes of rivers by reducing natural spring time flows and reducing the quantity and quality of habitat in the river downstream of the dam. Reduced downstream flows affect the quality of spawning, rearing and feeding areas for fish. Major water storage works in the Assiniboine River watershed include Lake of the Prairies and Theodore Reservoir. Smaller structures include weirs at Kamsack, Canora and Sturgis.

Drainage of wetlands in the Upper Assiniboine watershed increases runoff volumes and peak flows in years with low to moderate runoff (UARB 2000). Changes in land management practices such as loss of smaller woodlands have also been suggested as contributing to increased runoff in the basin although a cause-effect relationship has not been established (UARB 2000). Increased runoff has impacts to stream channels, fish habitat and water quality. Flows that govern the size and characteristics of stream channels occur during years with average runoff events. These 'bankfull flows' dictate the average width, depth and meander pattern of streams. Because the bankfull flow is the maximum flow that can be carried within the stream channel, the majority of stream bank erosion occurs during these flows. In a stable stream system, erosion, transportation and deposition of sediment are balanced and excessive sediment does not accumulate in the stream channel. Increases in the volume of average runoff events provide more power for stream erosion and additional sediment is eroded from the bed and banks and carried downstream (Gordon et al. 1992). Excess sediment in the stream channel covers important fish habitat such as gravel spawning areas and pool habitat important for overwintering fish. Accumulations of sediment cause the stream to become shallower but because similar or greater flow volumes are carried, the stream erodes laterally into its banks, causing further erosion and sediment deposition. In addition to impacts on habitat, the some of the eroded sediment is suspended in the water column and reduces water quality for downstream users.

Stream channelization, usually to support drainage activities, has significant impacts to fish habitat and water quality (McCarthy 1985). Channelization causes direct loss of habitat by changing a meandering channel to a straight channel, reducing the stream length and available area for fish to use. Channelization eliminates habitat diversity by removing pools and riffles and replacing them with wide, shallow stream beds devoid of habitat features. Channelization increases stream velocities by shortening the channel and steepening the slope, leading to increased erosion and downstream sedimentation. Deepening stream channels initiates down cutting and erosion of tributary streams entering the channelized stream. Erosion and sedimentation from channelization has major, negative impacts on fish habitat and reduces water quality for downstream users.

Unmanaged grazing along stream banks can damage stream banks directly by trampling and indirectly by reducing riparian vegetation cover that otherwise protects the banks from erosion by overland runoff and stream flow. Destabilization of stream banks from unmanaged grazing leads to erosion and downstream sedimentation of fish habitat.

Roads have numerous impacts on fish habitat. Road networks tend to increase runoff events by intercepting and redirecting overland flow into natural drainages. In otherwise undisturbed landscapes, roads have been identified as the chief source of sediment in streams (MacDonald et al. 1991). A major impact of roads relates to stream crossings. Improperly placed or undersized culverts reduce or prevent upstream passage of migrating fish with major impacts to fish populations. Road crossings that block spring spawning migrations of walleye, northern pike and other large-bodied fish species can have serious, long term consequences for fish populations in downstream lakes and rivers.

Sediment can be introduced to streams at road crossings from unstabilized fill at new crossings or from undersized culverts that wash out during high flow events. In addition to harming fish habitat, the fine sediments affect water quality for downstream users. Crossings that are designed and installed to provide adequate conditions for fish passage are much less likely to wash out during high flow events and provide a greater measure of protection for water quality.

Regulations

Numerous acts and regulations at both federal and provincial levels provide protection for fish and fish habitat and water quality. Highlights of some key sections of environmental legislation that is frequently used for protection of water resources are listed below. Refer to legislation for detail and interpretation.

Fisheries Act (Canada)

Section 35(1) – Prohibits, without approval, the harmful alteration, disruption or destruction of fish habitat.
Section 20(1) – Allows the Minister of Fisheries and Oceans to require installation of a fishway at obstructions (i.e. dams, weirs, causeways).
Section 22 (3) – Allows the Minster of Fisheries and Oceans to require flows of water downstream of obstructions.
Section 32 – Prohibits the destruction of fish by means other than fishing.
Section 36(3) – Prohibits the discharge of deleterious substances (including sediment) into waters frequented by fish.

Canadian Environmental Assessment Act (Canada)

Section 5(1) – Requires federal agencies to conduct an environmental assessment in situations where it is the proponent, provides land or money or issues approvals for projects to take place. The Act requires that all environmental impacts must be addressed before the federal agency can take action to allow or cause the project to proceed.

The Environmental Assessment Act (Saskatchewan)

Section 8(1) – Requires a Ministerial Approval for 'developments' as defined under section 2(d), i.e. an environmental assessment must be conducted for projects qualifying as developments under the Act.

The Environmental Management and Protection Act, 2002(Saskatchewan)

Section 35(1) – Prohibits, without approval, the discharge of any substance that may have adverse effects on water quality.

Section 36(1) - Prohibits, without approval, the alteration of the bed or bank of a water body, addition or removal of materials from water bodies and removal of vegetation from water bodies.
Note – Exemptions are provided for water bodies wholly enclosed by an individual's land and not connected to water bodies beyond that land. Additional exemptions are provided under *The Water Regulations, 2002.*

The Water Regulations, 2002 (Saskatchewan) (regulations pursuant to EMPA)

Section 3(1) – Provides exemptions to the requirement for a permit under section 36 of the *Environmental Management and Protection Act* for some activities including but not limited to, some culvert replacements, utility line installation, cultivation of intermittent watercourses, beaver dam removal, vegetation removal and grazing near water.

Saskatchewan Watershed Authority Act

Section 45 prohibits, without approval, the diversion, use or impoundment of water
Section 52(2) allows for environmental review of works that may impair the environment or natural resources.

Policies

DFO Policy for the Management of Fish Habitat – Describes how the habitat protection provisions of the *Fisheries Act* are to be administered.

Relevance to Source Water Protection

Populations of fish and their habitat serve to integrate the effects of a wide variety of activities on the landscape and in the water. The impacts of these activities are reflected in the health of the fish habitat and the fish communities. In general, activities that harm fish habitat and fish also harm the quality of source water for human use. Protection of fish habitat commonly serves to also protect water for human use.

A major overlap in fish habitat and water quality concerns is sediment. Sediment affects water quality and has detrimental impacts to fish and fish habitat. Various activities increase sediment loads in water. These include erosion and transport of sediment from land surfaces due to land use practices and lack of effective riparian buffers. Erosion from within the stream course itself is increased due to higher stream flows resulting from land use changes and wetland drainage. A major source of excess sediment in some streams originates from channelized sections of stream that lack the natural erosion reducing features of deep-rooted riparian vegetation, natural meanders and riffle-pool structures. Large, episodic sediment releases occur in many streams when poorly constructed or undersized culvert crossings wash out during high flows.

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xiv. Increased bank erosion of streams and rivers diminishes water quality. Increased erosion and sedimentation reduce fish spawning areas and habitat.

- ***Prepared by Rick Orr . . . DFO***

Description of the issue

Fish and fish habitat are damaged by excessive stream bank erosion. Damage to fish occurs from high levels of sediment suspended in the water and damage to fish habitat occurs from excessive sediment deposited on the stream bed. Excessive sediment that harms fish habitat also harms water quality for human use. Measures taken to protect fish habitat from the harmful effects of erosion and sedimentation concurrently protect water quality for human use.

The morphometry (shape) of a stream is dictated by a variety of factors beginning with the general characteristics of the landscape through which a stream flows (e.g. hilly or flat land) along with bedrock and soil characteristics of the area. Within the general constraints of topography and soils, a stream will develop a characteristic channel from the influence of the water flowing within its banks. The volume of flow that shapes a stream is referred to as the 'channel forming flow'. This is the volume of flow that occurs when the stream channel is full and generally occurs during years with average spring runoff. These channel forming flows erode and redeposit materials within the stream channel and influence the average width and depth of the stream and the length and sinuosity of the stream meanders.

Erosion, transport and deposition of sediment are balanced in a stable stream system. Increases in the volume of average runoff events provide more power for stream erosion and additional sediment is eroded from the bed and banks and carried downstream (Gordon et al. 1992). Excess sediment in the stream channel may cover important fish habitat such as spawning areas and pool habitat important for overwintering fish. Deposited sediment also influences the hydraulic processes of the stream, reducing the average depth and causing the stream to erode laterally, further increasing erosion of the stream banks. Long term increases in average runoff volumes cause the stream channel to readjust to a wider, deeper channel with a longer meander pattern. This readjustment takes place by means of erosion from the power of the additional volume of flow. Until the stream has readjusted, the eroded sediment is deposited in the stream channel and slowly moved downstream with long term impacts on fish habitat. In addition to impacts on habitat, the some of the eroded sediment is suspended in the water column and reduces water quality for downstream users.

Erosion in a stable stream channel is minimized by several mechanisms. The meander pattern of the stream reduces the slope of the channel and thereby reduces the velocity and erosive power of the water. Energy of the flowing water is dissipated by rock riffles and the presence of boulders, logs, brush and other naturally occurring woody debris. Erosion from stream banks is minimized by the presence of vegetation whose roots bind the soil and hold it in place against the flowing water. Flood flows over the stream banks result in very little erosion due to the protective influence of the vegetation.

Human activities can increase erosion from within the stream channel. The most obvious activities are the intentional removal of riparian vegetation for conversion to crop land and the loss of riparian vegetation as a byproduct of unmanaged grazing. Without the binding root mass, soil particles may slowly erode from the stream banks from flowing water or soil may enter the stream in large quantities as banks are undermined and collapse. Stream clearing activities such as removal of boulders, logs and brush in an attempt to allow water to drain more quickly also allow faster flows which erode the bed and banks of the stream, sending sediment downstream. Landscape scale activities such as wetland drainage increase the average size of runoff events (UARB 2000), causing the normally low levels of instream erosion to increase as the stream channel seeks to attain a new equilibrium in its width, depth and meander pattern. A stream channel that has developed over many years to carry a particular volume of flow obviously cannot accommodate significant increases and must adjust to a larger capacity. This adjustment takes place by erosion of the existing channel into a larger channel. This process may take decades or centuries and will produce sediment that must be transported downstream by the stream.

Stream channelization is sometimes carried out to improve drainage efficiency by providing a straighter channel with a larger cross-section. However, converting a meandering stream to a straight channel increases erosion and sedimentation by removing the protective vegetation from the stream banks and removing energy-dissipating rock and woody debris from the channel. In addition, straightening the channel increases the slope of the stream bed which increases the speed of flowing water and greatly increases its ability to erode the now unprotected stream bed and banks. Deepening stream channels also causes down cutting and erosion in tributary streams, adding further to downstream sedimentation.

Sediment may originate from sources associated with road crossings. Undersized culvert crossings may cause erosion when high velocity water exiting from the pipe is directed at the stream bank or when high water velocities at the culvert exit scour holes in the bed of the creek. Large amounts of sediment may enter a stream when poorly constructed or undersized culvert crossings wash out during high flow events.

Increased levels of sediment in water can harm fish directly by abrasive action on their gills or indirectly by reducing visibility and the fish's ability to feed. Sediment deposited on the stream bed can damage spawning areas, destroy fish eggs, cover food producing riffles and reduce the depth of pool habitat.

High concentrations of suspended sediment reduce water quality in several ways. Turbidity associated with suspended sediment is aesthetically unpleasing and carries adsorbed contaminants such as phosphorus which adds to nutrient loads. Suspended sediments complicate and increase costs of water treatment for human consumption (UARB 2000).

Regulations

Numerous acts and regulations at both federal and provincial levels provide protection for fish and fish habitat and water quality. Highlights of some key sections of environmental legislation that is frequently used for protection of water resources are listed below. Refer to legislation for detail and interpretation.

Fisheries Act (Canada)

Section 35(1) – Prohibits, without approval, the harmful alteration, disruption or destruction of fish habitat.
Section 36(3) – Prohibits the discharge of deleterious substances (including sediment) into waters frequented by fish.

Canadian Environmental Assessment Act (Canada)

Section 5(1) – Requires federal agencies to conduct an environmental assessment in situations where it is the proponent, provides land or money or issues approvals for projects to take place. The Act requires that all environmental impacts must be addressed before the federal agency can take action to allow or cause the project to proceed.

The Environmental Assessment Act (Saskatchewan)

Section 8(1) – Requires a Ministerial Approval for 'developments' as defined under Section 2(d), i.e. an environmental assessment must be conducted for projects qualifying as developments under the Act.

The Environmental Management and Protection Act, 2002(Saskatchewan)

Section 35(1) – Prohibits, without approval, the discharge of any substance that may have adverse effects on water quality.
Section 36(1) – Prohibits, without approval, the alteration of the bed or bank of a water body, addition or removal of materials from water bodies and removal of vegetation from water bodies.
Note – Exemptions are provided for water bodies wholly enclosed by an individual's land and not connected to water bodies beyond that land. Additional exemptions are provided under *The Water Regulations, 2002.*

The Water Regulations, 2002 (Saskatchewan) (regulations pursuant to EMPA)

Section 3(1) – Provides exemptions to the requirement for a permit under section 36 of the *Environmental Management and Protection Act* for some activities including but not limited to, some culvert replacements, utility line installations, cultivation of intermittent watercourses, beaver dam removal, vegetation removal and grazing near water.

Saskatchewan Watershed Authority Act

Section 45 prohibits, without approval, the diversion, use or impoundment of water
Section 52(2) allows for environmental review of works that may impair the environment or natural resources.

Policies

DFO Policy for the Management of Fish Habitat – Describes how the habitat protection provisions of the *Fisheries Act* are to be administered.

Relevance to Source Water Protection

Populations of fish and their habitat serve to integrate the effects of a wide variety of activities on the landscape and in the water. The impacts of these activities are reflected in the health of the fish habitat and the fish communities. In general, activities that harm fish habitat and fish also harm the quality of source water for human use. Protection of fish habitat also serves to also protect water for use by humans and domestic animals.

The problem of erosion and sediment concerns both fish habitat and water quality. Many activities increase sediment loads in water. Instream erosion is a major source of sediment in many streams. Instream erosion is increased due to higher flows from land use changes and wetland drainage. A major source of excess sediment in some streams originates from channelized sections of stream that lack the natural erosion reducing features of deep-rooted riparian vegetation, natural meanders and riffle-pool structure. Poorly constructed road crossings erode sediment from stream beds and banks due to high velocity water exiting undersized culverts. Large, episodic sediment releases occur in many streams when poorly constructed or undersized culvert crossings wash out during high flows.

References

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McCarthy, D.T. 1985. The adverse effects of channelization and their amelioration *in* Alabaster, John S (ed.) Habitat modification and freshwater fisheries. Proceedings of a Symposium of the European Inland Fisheries Advisory Commission. FAO.

Upper Assiniboine River Basin Study Main Report. 2000. Environment Canada , SaskWater, Manitoba Conservation.

xv. Conflicts between land use for agriculture and wildlife habitat should be resolved to give better direction for water management.

- ***Prepared by Doug Brook (DU), Warren Thomson (SWA), Brian Campbell (Sask Ag)***

The habitat that is identified as wildlife habitat plays a much larger role than just providing habitat for wildlife. Protection and/or proper management of the land within a watershed is critical to ensure a safe, reliable, sustainable water supply.

A healthy landscape that has been designed for source water protection will also provide suitable habitat for wildlife. In fact, wildlife population health provides an indicator of landscape health and the ability to provide quality water. There is a direct link and a landscape that is being altered and degraded is less capable of providing the many benefits to humans as well as wildlife.

Wetlands, riparian habitats and upland habitats are important natural landscape features that contribute to source water protection and watershed health. Conserving these features through sound and sustainable land use practices provides a multi-barrier approach to protecting source waters. Wetlands and riparian buffers have the capacity to reduce flows during runoff events, temporarily storing water and slowly releasing it to groundwater or discharging into creek systems. They also have the capacity to reduce watershed erosion and sedimentation by reducing flows and trapping sediments. The wetland and riparian buffer vegetation traps the sediment and the accompanying nutrients, pesticides and pathogens that may be contained in runoff. The shallow nature of wetlands allows light to fully penetrate the water column, which results in high biological activity that can accelerate the transformation or breakdown of pesticides and transform those elements into less harmful forms.

Sustainable land use practices are critical to maintaining watershed health. Cropping and grazing practices should minimize erosion and other negative impacts that can impede the ability of natural landscape features to improve water quality and quantity. Conservation of wetlands, riparian areas and upland cover is integral to source water protection and a fundamental component of any water management plan.

As seen in other source water protection watershed planning initiatives in other jurisdictions, a certain portion of land must be protected and managed as permanent cover and wetlands. Since haying and pasturing of cattle can be a suitable method of managing wildlife lands, most of the conflicts that exist between land use for agriculture and wildlife habitat are a result of land not being available for cultivation and the same conflict would result if the land were managed for source water protection. Therefore, the conflict tends to be more development versus non-development.

The benefits received by maintaining a healthy landscape can be in the immediate area or several miles away. Although what you do on your land impacts someone downstream, you have to consider that someone upstream is doing something that impacts you, either positive or negative.

What are the conflicts?

1. Agriculture is losing land to wildlife habitat.
   - Historical air photos of areas where complaints are taking place show that areas allegedly being lost to wildlife were flooded in wet years in the past. In some cases, drainage in the area allowed the area to be farmed or drought conditions allowed the area to be farmed.
   - The UARB Study has estimated that approximately 95 percent of the drainage in the basin is unauthorized. Therefore, even with a portion of the land being lost to wildlife during wet years, a larger portion of native habitat has been lost to agriculture. The cumulative impact of a large number of unauthorized drainage projects is significant.
   - Agriculture has taken far more from wildlife habitat than will ever be restored. The UARB Study states that an average of 81 percent of the wetland area has been impacted by drainage (p.112) with the majority of temporary wetlands completely cultivated (p.118). These areas are also no longer available to provide the many source water protection benefits they would have supplied and in fact can contribute to additional negative impacts to water quality and quantity due to the activities taking place over them
   - Currently 70 percent of all seasonal and 20 percent of all temporary wetlands are cultivated in the basin. A greater understanding on the definition of a wetland is required to understand the extent of the impacts.
   - An increase from 40 to 64 percent cropping in the basin must be impacting sedimentation in runoff.
2. The most productive land is beneath wildlife habitat.
   - The reference is mostly targeted at wetland habitat, which is an extremely productive ecosystem. The high productivity of these systems is also why they are so effective in removing contaminants from the water and are a critical component of source water protection.
   - Grain farming is the main concern. A large portion of the watershed is better suited for other ag activities (i.e. livestock) which are compatible with wildlife conservation efforts and source water protection and keep land available for agriculture.
   - In 1995 Canada removed the Crow Rate Subsidy on grains produced on the Canadian Prairies. Removal of this subsidy increased freight rates dramatically across the Prairies. East Central Saskatchewan was impacted to the greatest extent. The high yields and lower quality grains frequently produced in the area compounded this impact. An average size farm (1200 acres) producing wheat, barley and canola in the Yorkton area would have had a rail freight cost of $14,800 in

1993/94. In 1996/97 that same farm would have had a rail freight cost of $43,200. By comparison, a similar farm near Saskatoon (an average freight cost location on the Canadian Prairies) would have had rail freight costs of $12,000 in 1993/94 and a $29,000 in 1996/97. While both hypothetical farms experienced a substantial increase in rail freight cost the Yorkton area experienced a $28.400 increase while the Saskatoon area only experienced a $17,000 increase over the time period.

- After the elimination of the Crow Rate Subsidy, Agriculture and Agrifood Canada predicted that large acreages in East Central Saskatchewan would be converted to perennial cover. This conversion was expected due to decreased net returns from annual crop production making production of forages and beef cattle comparatively more profitable. The high productive capacity of the area also seemed to provide an advantage of almost guaranteed high forage yields both on pasture and hay land. The conversion to perennial cover has been slow and instead, a movement to larger grain operations with larger equipment occurred to try to improve efficiencies. Recently, initiatives such as the Last Cattle Frontier have promoted the area for cattle and resulted in families from Alberta moving to the area and converting cultivated land to perennial cover. These initiatives are supported by wildlife organizations and compliment each other.

3. Society should pay attitude.

- Society appears to be willing to pay through government and NGO incentive programs and donations to wildlife organizations. As the link between source water protection and wildlife habitat is better understood, it will be easier to promote the value of ecological goods and services to society at large, to the wildlife resource, and to the landowner and design incentive programs accordingly.
- Conservation organizations offer many programs for agricultural producers that offer financial aid to protect native areas or modify land use practices in a way that provide benefits to wildlife and source water protection. These programs have been very successful with livestock operations but have had limited success with grain producers with the exception of winter cereal programs.
- Farmers and farm groups should promote benefits of proper land use to source water protection and wildlife as a method of securing additional government funding. Conservation and the environment are key initiative in many government agenda's.
- Society needs to better understand the links between water quality/quantity and habitat as it relates directly to farm operation and local municipalities.

4. From UARB Study (4.2) - *Some landowners voiced concerns about the amount of wildlife habitat that has been secured within the Basin by government and non-government agencies. They are of the viewpoint that too much habitat has been secured, that agencies have unfair advantages because of larger financial resources and are paying above market value for land, and are removing productive farmland from agricultural use.*
    - Need to determine amount and percentage of basin secured by agencies.
    - As discussed earlier, the wildlife land is playing an important role in source water protection at minimal cost (or no cost in the case of DUC land) to the local users.
    - Land purchased by conservation organizations are purchased at fair market value and subject to review by the Farm Land Security Board.
    - Land secured through Conservation Easements and Management Agreements are still available for agriculture since they only restrict drainage and breaking of the land and allow grazing, haying and other activities.
    - Not all WHPA land and DUC land are removed from Agricultural use. WHPA land administered through Sask Ag and Food is leased out to producers. DUC land is managed as needed using ag practices such as haying and grazing.
    - Purchase of conservation land would not be required if habitat was secured through incentive programs. Taxes due to ownership of land by conservation groups places a financial burden on these groups.
    - More information needs to be collected on the economics of drainage. Is it financially sustainable over the long term when crops are lost during wet years? Should government funding and subsidies be paid on unauthorized drained land (i.e. US Swampbusters legislation)?
5. Crop Damage

    Compensation:

    - Saskatchewan Crop Insurance Corporation (SCIC) manages the current Waterfowl Crop Damage Compensation program. In 2003, the details included a maximum of 85% payout with a $200 deductible per crop. Details are currently not available for the 2004 fall season. All seeded commercial crops are eligible and a producer does NOT have to be a crop insurance customer to be eligible for compensation. Spring damage compensation is eligible but is paid based on an agent damage claim record, which may take until fall to determine the level of damage.

    Bait sites and Lure crops:

- Conservation organizations such as DUC have continued commitment to the maintenance of these sites where the province intends on continued operation. In many cases the province has chosen not to operate these sites and as a result little or no maintenance has occurred. Currently, several sites are being operated throughout the province. However, the only active site in the Upper Assiniboine Basin is the Leech Lake bait site south of Yorkton.
- Although levels of waterfowl depredation are partially related to populations, increased damage is largely a factor of the timing and length of harvest in conjunction with the fall flight. The potential for depredation increases when preferred crops are in close proximity to concentrated numbers of the migrating waterfowl and when climatic conditions (cool & wet), result in crops lying in swaths for extended periods of time. At high or low waterfowl populations the right combination results in a high level of crop exposure and potentially high levels of depredation
- Many landowners are still unaware of SCIC Big Game and Waterfowl Compensation programs and some are reluctant to go through the claim procedure. The government uses the record of claims from this program as a direct indication of the level of crop damage. High claim records will trigger a government response that may include bait station operation or other program. The Watershed Advisory Committee should encourage producers who suffer a depredation loss to file a claim so the government gets a more accurate picture of crop loss and have the ammunition to deal with it.
- Snow geese and Canada geese play a major role in crop depredation. However, these species breed primarily in the forested and arctic regions of northern Canada. Habitat conservation efforts in Saskatchewan have little effect on the recent goose population increases.

Education

Education and communication are critical in order to resolve most of the conflicts between agricultural land use and wildlife. Partnerships between ag organizations and wildlife groups would aid in this process. The planning process should address what type of programs to be delivered and who will deliver them.

General

The resolution of these conflicts is just one part of a complicated planning process and will involve some difficult and controversial decisions. Concern has been expressed that the WAC may not have the expertise or will to handle these decisions and implement them effectively. Planning and the resulting enforcement/implementation of the activities outlined in the plan require a level of expertise that may not exist in the current structure or within the workload of existing individuals.

Since land use and source water protection are directly linked, the SWA planning process needs to be coordinated with any RM land use planning process. Consideration should be given to hiring a professional planner either as staff or a consultant to ensure the success of this initiative. SARM officials should be contacted to determine where they are headed with land use planning and zoning.

xvi. Oil and Gas Industry is a threat to surface and groundwater in the Basin.

The Advisory Committee has expressed concerns with this industry, which is a relatively new activity to the Assiniboine Watershed. Recently, several new exploration activities are now occurring in parts of the watershed, such as near Preeceville, Kamsack and south of Yorkton. Historically, there was activity near Kamsack.

There have been several oil and gas surface and ground water contamination incidents in the industry across North America that have been reported in the media. This has made most rural land owners very aware of the potential source water contamination that can occur.

Hydrocarbons can have enormous long lasting impacts on aquifers. Once an aquifer is contaminated with hydrocarbons it can be extremely difficult to remediate. The impacts on surface water affect water quality and all forms of life in both direct and direct association. The impact is usually highly visible. Surface water ecosystems can recover from relatively small oil incidents much faster than groundwater.

In both scenarios it does not take much hydrocarbon volume to have a major impact on a large volume of source water. A fact often quoted is that ‘One litre of oil can contaminate up to 2 million litres of water’. There are concerns in all aspects of the oil and gas industry. Exploration, development, production, storage, transportation, and decommissioning all have potential impacts on source water.

Within Saskatchewan, the oil and gas industry is a highly regulated industry. It should be noted that although highly regulated, this does not necessarily guarantee no significant impacts could occur. The Province wants the economic benefits of the oil and natural gas industry, while at the same time minimizing environmental impacts. One measure taken was the formation of the

Saskatchewan Petroleum Industry/Government Environment Committee

The Committee

The Saskatchewan Petroleum Industry/Government Environment Committee (SPIGEC) was formed in 1992 in response to an identified need for government and industry to work in concert to resolve provincial environmental management issues. SPIGEC's overriding goal is to ensure the continued growth of the oil and natural gas industry, with development proceeding in a manner which minimizes adverse environmental effects.

The Committee's membership reflects the broad interest in the oil and gas industry. Provincial government agencies represented include:

- Saskatchewan Environment
- Saskatchewan Energy and Mines
- Saskatchewan Agriculture and Food
- and others, on a project-specific or issue-specific basis.

Industry associations represented include:

- Canadian Association of Petroleum Producers
- Small Explorers and Producers Association of Canada
- Canadian Association of Oilwell Drilling Contractors
- Canadian Association of Geophysical Contractors
- Petroleum Services Association of Canada.

Through its members, SPIGEC also has ties with the Canadian Gas Association, the Canadian Energy Pipelines Association, the International Right-of-Way Association and the Saskatchewan Environmental Industries and Managers Association. The SPIGEC group includes staff of the various industry associations, as well as representatives of interested individual companies.

SPIGEC members are expected to take information back to their departments or associations, and to bring input from their constituents to the table.

Procedures

The requirement for environmental protection is taken as a given, and the Committee seeks to find practical means by which Saskatchewan's environmental objectives can best be achieved. Subcommittees are formed to address specific items, and to bring forward recommendations for consideration by the entire Committee. Decisions are by consensus. Topics may be identified by any member department or organization at any time. Annually, issues are reviewed by the membership, and priorities established for the following year. Emphasis is placed on highest priority matters, with defining criteria including:

- Level of industry and government interest
- Level of public interest
- Level of environmental and economic impact
- Ability of SPIGEC to influence the outcome
- Availability of resources to address the issue.

The Committee meets about eight times per year.

Issues Management

For 2001, issues being addressed include:

- Climate Change
- Venting and Flaring
- Remediation Guidelines
- Waste Management Standards
- Representative Areas Network
- Land Use Planning
- Legislation and Process
- Federal/Provincial Co-ordination
- Harmonization/Canada-Wide Standards
- Canada Environmental Assessment Act
- Species at Risk Legislation
- Wildlife Habitat Protection Act Amendments
- Review of Saskatchewan Environmental Protection Legislation
- Cumulative Impact Assessment.

In some cases, SPIGEC may deal with an issue over a relatively short period of time, and in other instances the group will monitor an issue for months or years.

For more information, please contact:

- ○ *Your industry association*
- ○ *Larry Kratt, Nexen/Wascana Energy – 306-781-8287*
- ○ *Rick Stilling, Sask. Environment and Resource Management – 306-933-7933*

Environmental Protection Guidelines

SPIGEC has released a series of environmental protection guidelines. These procedures have been developed, in part, to provide industry with the tools necessary to enhance environmental performance. Government utilizes the guidelines to direct industry in the matters covered, and has an expectation that identified procedures will be followed in Saskatchewan oil and gas operations. Guidelines released to date are:

No. 1. Waste Management Guidelines for the Saskatchewan Upstream Oil and Gas Industry (1996).

This SPIGEC guideline provides comprehensive information on regulatory requirements with respect to the handling, storage, transportation, waste minimization, treatment and disposal of hazardous and non-hazardous oilfield waste. This Guideline is being reviewed in 2000.

No. 2 Restoration of Well Sites and Associated Facilities on Cultivated Lands in Saskatchewan (1999).

This SPIGEC guideline provides a brief overview of key concepts involved in biophysical site restoration.

No. 3 Restoration of Spill Sites on Saskatchewan Agriculture and Pasture Land (1999).

This SPIGEC guideline provides practical restoration and remediation approaches to upstream petroleum product spills on agriculture and pasture land.

No. 4 Saskatchewan Upstream Petroleum Sites Remediation Guidelines (1999).

This SPIGEC guideline provides comprehensive environmental clean-up criteria for contaminated upstream petroleum sites.

No. 5 Environmental Site Assessment Procedures for Upstream Petroleum Sites (1999).

This is a supporting guideline to SPIGEC Guideline No. 4. It is designed to provide step by step procedures to assist environmental professionals in conducting Phase I and Phase II environmental site assessments.

Environmental Operating Guidelines for the Upstream Petroleum Industry (2001).

The Committee is currently completing a major review and revisions to the 1992 Environmental Operating Guidelines for the Saskatchewan Petroleum Industry. The new guidelines will be released as a Canadian Association of Petroleum Producers' (CAPP) document.

Copies of the guidelines are available at:
http://www.ir.gov.sk.ca/Default.aspx?DN=3891,3620,3384,2936,Documents

Environmental Guidelines

The following are additional references listed on the SE website.

PDB ENV 01 - GL 97-01 Construction and Operation of Oily Byproduct Storage Structures
PDB ENV 01 - GL 97_01 Construction and Operation of OBSST JAN 98.pdf, 155.7 KB

PDB ENV 02 - GL 97-02 Guidelines for Road Spreading and Roadbed Incorporating Oily Byproducts
PDB ENV 02 - GL 97_02 OBSST Road Spreading and Roadbed Incorporation Gudielines NOV 98.pdf, 55.3 KB

PDB ENV 03 - SAWDC Methods of Road Spreading Oily Byproducts
PDB ENV 03 - SAWDC Road Spreading Methods.pdf, 30.1 KB

PDB ENV 04 - SPIGEC1 Upstream Waste Management Guidelines
PDB ENV 04 - SPIGEC1 Waste Management Guidelines.pdf, 465.5 KB

PDB ENV 05 - SPIGEC2 Oil and Gas Site Physical Restoration Guidelines
PDB ENV 05 - SPIGEC2 Restoration.pdf, 30 KB

PDB ENV 06 - SPIGEC3 Spill Site Reclamation Guidelines
PDB ENV 06 - SPIGEC3 Spill Reclamation.pdf, 68.1 KB

PDB ENV 07 - SPIGEC4 Upstream Contaminated Sites Remediation Guidelines
PDB ENV 07 - SPIGEC4 Site Remediation.pdf, 295.3 KB

PDB ENV 08 - SPIGEC5 Environmental Site Assessment Guidelines
PDB ENV 08 - SPIGEC5 Environmental Site Assessment.pdf, 60.6 KB

PDB ENV 09 - GL99-01 Drilling Waste Management Guidelines
PDB ENV 09 - GL99-01 Drilling Waste Management Guidelines.pdf, 302.9 KB

PDB ENV 10 - Draft Landfarming Guidelines
PDB ENV 10 - Draft Landfarming Guidelines.pdf, 112.2 KB

PDB ENV 11 - GL2000-01 Frac Fluid and Sand Disposal Guidelines
PDB ENV 11 - GL2000-01 Frac Fluid and Sand Disposal Guidelines.pdf, 264.8 KB

PDB ENV 12 - GL 2000-02 Interim Draft Landfilling Requirements for Wastes Generated from Upstream Oil and Gas Industry
PDB ENV 12 - GL 2000-02 Interim Draft Landfilling Requirement.pdf, 34.2 KB

PDB ENV 13 - S-01 Saskatchewan Upstream Industry Storage Standards
PDB ENV 13 - S-01 Saskatchewan Upstream Industry Storage Standards.pdf, 335.9 KB

PDB ENV 14 - Appendix 6 of S-01 Draft NORM Storage Requirements July 2003
PDB ENV 14 - Appendix 6 of S-01 Draft NORM Storage Requirements July 2003.pdf, 133 KB

PDB ENV 15 - Guidelines for Flare Tanks Used While Drilling a Well
PDB ENV 15 - Flare Tank Used While Drilling a Well January, 2002.pdf, 73.1 KB

PDB ENV 16 - Gas Migration Testing Guidelines
PDB ENV 16 - Gas Migration Testing Guidelines.pdf, 90 KB

The Saskatchewan Environmental Assessment Act

Guide to Proposal Development - Oil and Natural Gas Projects

Requests for review of oil and natural gas projects under *The Environmental Assessment Act* in Saskatchewan are to be provided to the appropriate regional office of Saskatchewan Environment and Resource Management (SERM) as follows:

- all seismic projects whether on Crown or private land;
- all drilling (including exploratory and strat test wells) flowline/pipeline projects, access routes and production facilities on **all** Crown land and on **private land** as outlined in SERM's **Checklist for Activity (Excluding Seismic) on Private Land in Saskatchewan**; and
- any project that has the potential to meet the definition of "development" under *The Environmental Assessment Act*.

The information described in this guide is required to complete reviews necessary under *The Environmental Assessment Act*. **Decisions made in relation to that Act do not convey any authority to enter onto the land to complete work.** Leases/approvals to enter onto land administered by **Saskatchewan Agriculture and Food (SAF) must be obtained from the appropriate SAF regional office.** Approval to enter onto Crown land administered by any other provincial Crown agency must be obtained from the agency responsible for the land where the work is to occur. Approval to enter onto private land must be obtained from the land owner.

The following are excerpts taken from the guidelines detailing the project review process

PROJECT EVALUATION

Describe how the development plans relate to environmental considerations in the area including: sensitive areas (e.g. steep slopes, riparian areas, wetlands, highly erodible soils) lands designated in **The Wildlife Habitat Protection Act**, other important wildlife habitat , etc.

(a) Potential Impacts and Protection / Mitigation Measures

- consider potential site specific impacts on wildlife, aquatic resources, riparian areas and wetlands, vegetation, soils, rare and endangered species and unique features and outline measures to mitigate impacts
- describe the measures you will take to minimize surface disturbance (timing, equipment and construction methods, use of existing routes, seismic lines, natural openings, etc.)
- some field work may be required for these evaluation

The proposal should describe the sources of environmental impacts that could result from the project and proposed methods of avoiding or minimizing those impacts. For example, considerations should include impacts of:

- new access
- blading or other access upgrades
- stripping lease, flowline/pipeline route, etc
- effects on slopes (cut and fill)
- stream crossings
- impacts on wetlands, riparian areas
- tree/brush removal

Alternately, the proposal may confirm that such sources of impact will not be an issue and provide supporting rationale

The proposal should estimate the potential to affect rare species based on historical or habitat information. Field evaluation of development sites for rare and endangered species will be required if historical or habitat information indicates potential occurrence and if project timing is appropriate. Contact the SERM regional office for information on particular locations.

(b) Reclamation Plan

Describe reclamation plans including: timing; re-contouring; re-vegetation methods (seed mixtures, tree/shrub planting, etc.) and fencing, erosion protection and other protection measures.

- the proposal should indicate when reclamation will be done, how it will be done and how often it will be checked to ensure that it was effective
- proponents should refer to the SAF Development/Restoration Plan Guidelines (Appendix A in Restoration of Saskatchewan's Agricultural Crown Rangelands - Guidelines and Procedures for Developers) for projects on lands under SAF administration.

(c) Timber Salvage

- Estimate volume to be removed and average d.b.h. (diameter at breast height) where applicable
- Outline timber salvage plans

Proponents should discuss salvage requirements and plans with the appropriate SERM EcoRegion early in the planning stages of any project in timbered areas.

WASTE MANAGEMENT PRACTICES

Describe proposed waste management handling and disposal practices for this project

it is sufficient to state that waste handling will be consistent with the Waste Management Guidelines for the Saskatchewan Upstream Oil and Gas Industry (developed by the Saskatchewan Petroleum Industry / Government Environment Committee) if you intend to follow those guidelines.

Proponents should provide information on any aspect of the project where plans for waste handling are not consistent with those guidelines or SEM requirements.

ENVIRONMENTAL MONITORING

Describe your monitoring commitments in regard to:

- the stages of the development which will be monitored
- who will do the monitoring
- the frequency at which monitoring will be done, both during construction to ensure minimal impact and following construction to ensure reclamation measures are effective

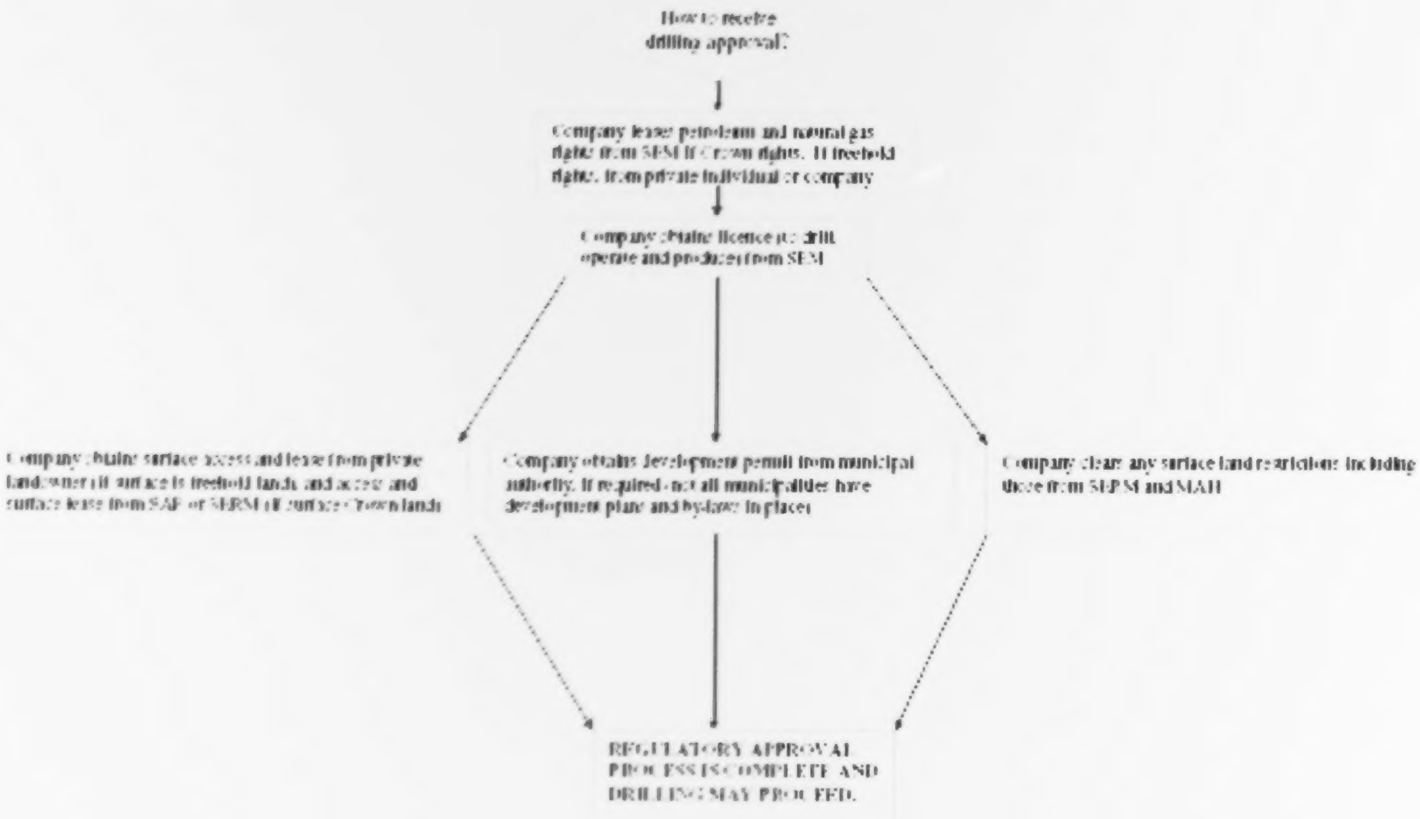
The proposal should indicate whether a monitor will be present and if so, who the monitor will be and what his/her qualifications are. For what aspects of the project will the monitor be present?

What type of monitoring will be done following completion of work to ensure mitigation and reclamation efforts have been successful? What will be the frequency of checks and for how long following completion of the work will they continue?

What follow-up reporting is planned?

The following flowcharts depict the provincial review process

THE PROVINCIAL REGULATORY APPROVAL PROCESS – PETROLEUM AND NATURAL GAS DRILLING (AN OVERVIEW)



How to receive drilling approval?

Company leases petroleum and natural gas rights from SEM if Crown rights. If freehold rights, from private individual or company

Company obtains licence (to drill, operate and produce) from SEM

Company obtains surface access and lease from private landowner (if surface is freehold lands) and access and surface lease from SAF or SERM (if surface Crown lands)

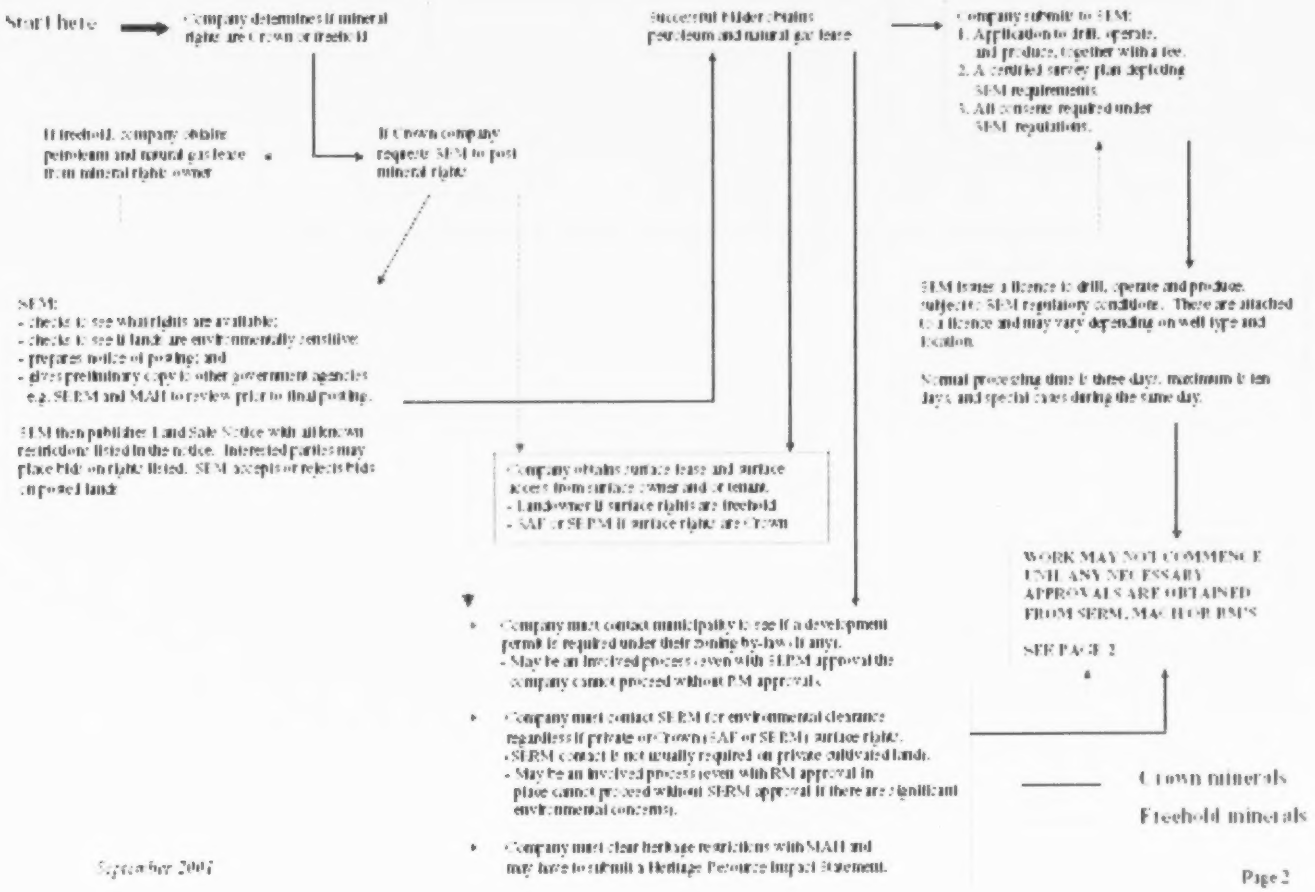
Company obtains development permit from municipal authority, if required (not all municipalities have development plans and by-laws in place)

Company clears any surface land restrictions including those from SERM and MAH

REGULATORY APPROVAL PROCESS IS COMPLETE AND DRILLING MAY PROCEED.

THE PROVINCIAL REGULATORY APPROVAL PROCESS – PETROLEUM AND NATURAL GAS DRILLING (DETAILED)

SEM AND MAH



Start here

Company determines if mineral rights are Crown or freehold

If freehold, company obtains petroleum and natural gas lease from mineral rights owner

If Crown company requests SEM to post mineral rights

SEM:
- checks to see what rights are available;
- checks to see if lands are environmentally sensitive;
- prepares notice of posting; and
- gives preliminary copy to other government agencies e.g. SERM and MAH to review prior to final posting.

SEM then publishes Land Sale Notice with all known restrictions listed in the notice. Interested parties may place bids on rights listed. SEM accepts or rejects bids on posted lands.

Successful bidder obtains petroleum and natural gas lease

Company submits to SEM:
1. Application to drill, operate, and produce, together with a fee.
2. A certified survey plan depicting SEM requirements.
3. All consents required under SEM regulations.

SEM issues a licence to drill, operate and produce, subject to SEM regulatory conditions. These are attached to a licence and may vary depending on well type and location.

Normal processing time is three days, maximum is ten days, and special cases during the same day.

Company obtains surface lease and surface access from surface owner and/or tenant.
- Landowner if surface rights are freehold
- SAF or SERM if surface rights are Crown

- Company must contact municipality to see if a development permit is required under their zoning by-law (if any).
  - May be an involved process (even with SERM approval the company cannot proceed without RM approval).
- Company must contact SERM for environmental clearance regardless if private or Crown (SAF or SERM) surface rights.
  - SERM contact is not usually required on private cultivated lands.
  - May be an involved process (even with RM approval in place cannot proceed without SERM approval if there are significant environmental concerns).
- Company must clear heritage restrictions with MAH and may have to submit a Heritage Resource Impact Statement.

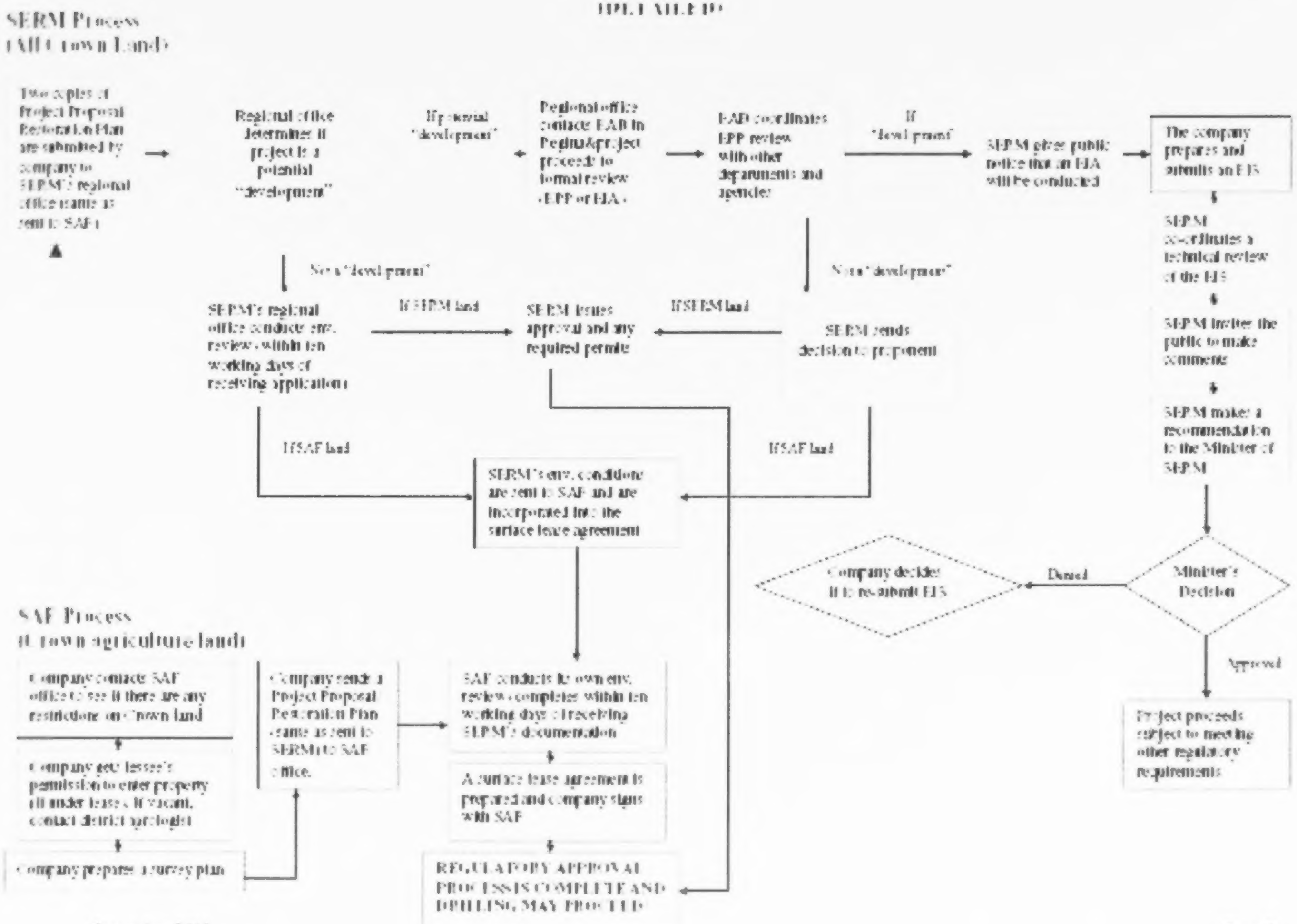
WORK MAY NOT COMMENCE UNTIL ANY NECESSARY APPROVALS ARE OBTAINED FROM SERM, MACH OR RM'S

SEE PAGE 2

——— Crown minerals

Freehold minerals

DETAILED


SERM Process
(All Crown Land)
Two copies of Project Proposal Restoration Plan are submitted by company to SERM's regional office (same as sent to SAF)
Regional office determines if project is a potential "development"
If potential "development"
Regional office contacts EAB in Regina&project proceeds to formal review (EPP or EIA)
EAB coordinates EPP review with other departments and agencies
If "development"
SERM gives public notice that an EIA will be conducted
The company prepares and submits an EIS
SERM co-ordinates a technical review of the EIS
SERM invites the public to make comments
SERM makes a recommendation to the Minister of SERM
Not a "development"
Not a "development"
SERM's regional office conducts env. review (within ten working days of receiving application)
If SERM land
SERM issues approval and any required permits
If SERM land
SERM sends decision to proponent
If SAF land
If SAF land
SERM's env. conditions are sent to SAF and are incorporated into the surface lease agreement
Company decides if to resubmit EIS
Denied
Minister's Decision
Approved
Project proceeds subject to meeting other regulatory requirements
SAF Process
(Crown agriculture land)
Company contacts SAF office to see if there are any restrictions on Crown land
Company gets lessee's permission to enter property (if under lease) (if vacant, contact district agrologist)
Company prepares a survey plan
Company sends a Project Proposal Restoration Plan (same as sent to SERM) to SAF office.
SAF conducts its own env. review (completes within ten working days of receiving SERM's documentation)
A surface lease agreement is prepared and company signs with SAF
REGULATORY APPROVAL PROCESS IS COMPLETE AND DRILLING MAY PROCEED

xvii. The development of Regional waste management sites may be of concern to water quality.

- This issue has been moved and combined with item 4.

C. Water Quantity Related

xviii. Surface water supply may not be adequate to meet future water demand.

- Most communities in the Assiniboine watershed utilize groundwater as their source for drinking water. Where groundwater quality is poor or volumes are limited, rural citizens do utilize surface water.
- Refer to the Assiniboine Source Water Protection Plan or the Assiniboine River Watershed Backgroung report for further details on this issue.

ixx. Groundwater demand could exceed the sustainable groundwater supply

The Saskatchewan Watershed Authority is responsible for managing and protecting the groundwater resources in Saskatchewan. Continual activities have been established to obtain further knowledge focusing towards regulating water usage and the protection of source water. These include the regulation of groundwater works in Saskatchewan, monitoring wells, and the geology and groundwater mapping program.

Regulatory

Groundwater use is managed by the Saskatchewan Watershed Authority (SWA). The SWA is responsible for administering the regulatory approval process for the construction and operation of water wells and other groundwater works. Any use of groundwater requires an approval from the SWA, with the exception of domestic wells. Groundwater works requiring approval include municipal, industrial (including groundwater de-watering), intensive livestock operations, commercial, public institutions, and irrigation projects. The approval process includes several stages:

1. Application for Permit to Conduct Groundwater Investigation
2. Permit to Conduct Groundwater Investigation issued
3. Application for Approval to Construct and Operate Works and Water Rights License to Use Groundwater
4. Decision to Issue or Refuse License

Approvals are required to ensure the groundwater works projects are sustainable and do not cause adverse impacts to the environment and existing groundwater users. The approval process includes the submission of an Application for Permit to Conduct Groundwater Investigation by the proponent. Included in the application is the land location of the proposed development, the intended use of the water, estimated annual quantity and pumping rate. Upon receiving the required information, SWA will review and identify if there is any potential conflicts. If there are no apparent conflicts, a Permit to Conduct Groundwater Investigation will be issued to the proponent. The permit includes any hydrogeological information and general guidelines pertaining to the detail and type of information, which should be collected during the investigation. The groundwater investigation must be supervised or conducted by a qualified hydrogeologist. Two copies of the investigation report must be submitted to SWA within 60 days of completion.

The investigation report should include water well information, original borehole geophysical and descriptive logs of all testholes, copies of well and observation well completion records and a minimum of a 24 hour pump test to determine estimates of the well, aquifer, and basin yield. If the groundwater investigation was successful, the project proponent is required to file an Application for Water Rights License and Approval To Construct and Operate Works. The application must include a general plan illustrating the proposed works and location relative to legal boundaries. The groundwater investigation report is used as a base document to support the application. The report should identify any potential adverse impacts and develop mitigation procedures, if required.

In the situation where a potential conflict with existing groundwater users or the effects will be significant, the SWA may require public consultation. The public consultation may result in additional investigation, special terms or conditions, development of mitigative plans, or denial of Approval of works. For groundwater works that have been approved and allowed to obtain groundwater, water level measurements must be periodically submitted from the observation wells to SWA. SWA will review and evaluate the information and if impact has occurred, additional restrictions or special terms may be implemented to the groundwater works project.

Observation Well Network

The Saskatchewan Watershed Authority and the Saskatchewan Research Council (SRC) has established an observation well network to monitor fluctuations in certain aquifers in Saskatchewan. The network was established in 1964, with the initial intention to measure natural groundwater fluctuations. Locations of the wells were selected based on their geohydrological variety and in aquifers where SRC was involved in more detailed geohydrological activities. Consequently, the observation well network does not obtain information from all aquifers in Saskatchewan. Greater knowledge is required from the aquifers because the history of the data is less than 40 years.

The Saskatchewan Watershed Authority established its observation well network in 1996. The network complemented the SRC observation network. The objective of the SWA network was to monitor water levels in areas of high development such as Regina and Yorkton area aquifers. Water level measurements are also obtained from groundwater works projects that may cause a potential impact on existing groundwater users.

Water levels are monitored in certain aquifers at several locations throughout the Upper Assiniboine River Basin. Figure 1 illustrates the spatial extent and distribution of these observation wells. Table 1 lists the location and completion depths of the observation wells in the watershed. Water level measurements are recorded from certain aquifers. The majority of the observation wells are located in aquifers surrounding the City of Yorkton. To date, there are nine (9) observation wells operated by SWA and six (6) by SRC, monitoring the Yorkton aquifer systems continually from digital recorders. A brief description and water level measurements of the observation wells can be obtained through the SWA website.

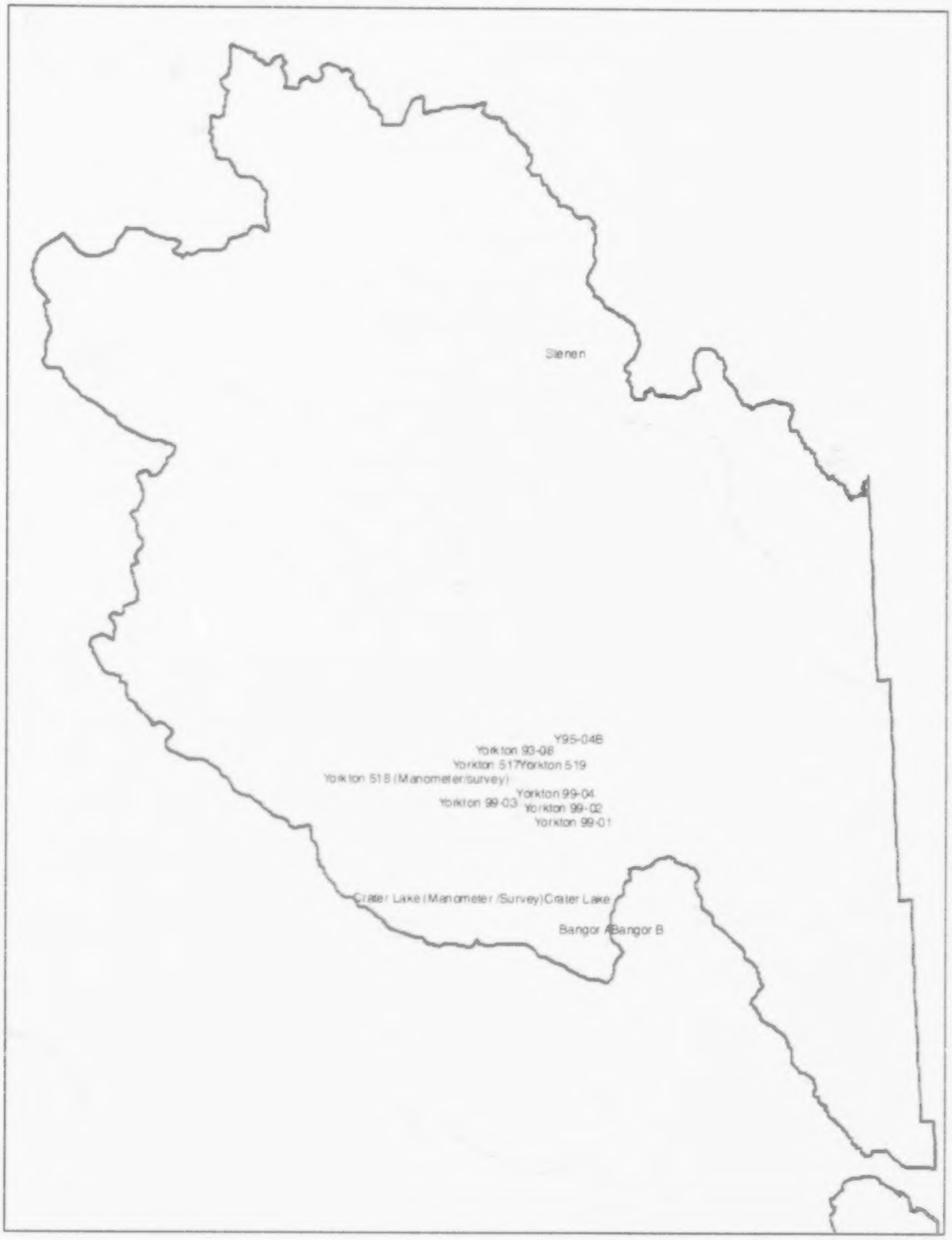

Stenen
Y95-04B
Yorkton 93-08
Yorkton 517Yorkton 519
Yorkton 518 (Manometer/survey)
Yorkton 99-04
Yorkton 99-03
Yorkton 99-02
Yorkton 99-01
Crater Lake (Manometer /Survey)Crater Lake
Bangor ABangor B

Figure 1. Spatial distribution of observation wells in the Upper Assiniboine River Basin.

Well	Land Location	Depth of Well (M)	Operator
Bangor A	NE16-13-22-03-W2	39.16	SRC
Bangor B	NE16-13-22-03-W2	15.27	SRC
Crater Lake	NW08-02-23-04-W2	11.58	SRC
Stenen	SE16-07-33-03-W2	14.63	SRC
Yorkton 517	SW02-21-25-04-W2	40.23	SRC
Yorkton 519	SW02-21-25-04-W2	6.52	SRC
Yorkton 93-03	NW13-31-25-03-W2	9.804	SWA
Yorkton 93-04	SW12-31-25-03-W2	41.79	SWA
Yorkton 93-07	SE02-35-25-04-W2	16.52	SWA
Yorkton 93-08	NE09-27-25-04-W2	21.98	SWA
Yorkton 95-04B	S14-31-25-03-W2	13.79	SWA
Yorkton 99-01	SE09-34-24-04-W2	42.203	SWA
Yorkton 99-02	SE09-04-25-04-W2	38.359	SWA
Yorkton 99-03	SW01-33-24-04-W2	23.54	SWA
Yorkton 99-04	NW14-33-24-04-W2	23.47	SWA

Table 1. Description of observation wells in the Upper Assiniboine River Basin.

Groundwater Mapping

Prior to the 1960's, little information was known on the geology and groundwater resources in Saskatchewan. During the 1960's, SRC initiated the mapping program to identify and delineate potential water bearing zones. These maps provided a better understanding of the regional geology by illustrating the bedrock geology and topography. It also established the extent of major bedrock aquifers, the thickness of glacial drift, and defined the economical depth of groundwater exploration. These maps provided a basis for evaluation of groundwater resources in Saskatchewan. The maps indicated the occurrence, quality, and behaviour of the groundwater resources in supporting the development, management, and protection of these water supplies.

An update of these maps began in 1986. Second-generation mapping was initiated by SWA and SRC. The objective of this program was to further define the bedrock geology and delineate potential water bearing zones in the glacial drift deposits. The maps illustrated the location, extent, and depth of potential aquifers throughout Saskatchewan at a regional scale of 1:250,000. Geological cross sections were also produced to complement the groundwater maps. Twenty (20) maps were produced from the second generation program covering the extent of province except for the Regina (72I) and Saskatoon (73B) map sheets.

The third generation mapping program began in the late 1990's. The objective of the program was to identify and delineate the potential water bearing zones for the Regina (72I) and Saskatoon (73B) map sheets. Third generation maps are being completed using the Geographic Information System (GIS). To date, the Regina map sheet is in draft format and the Saskatoon map sheet has yet to be completed.

Previous Studies

An overview study of the Assiniboine River Basin was completed in 1995. The report provides a general overview of the water use, water supply, physiography, and management issues. In 1999, SRC completed a geology and groundwater resources studies for the Upper Assiniboine River Basin. The geology and groundwater resources study was a cooperative effort between the Provinces of Saskatchewan, Manitoba, and Canada towards the development of a detailed water management plan. It provided an overview of the basic geologic setting and available groundwater resources. The spatial extent and distribution of aquifers were delineated at a regional scale.

Groundwater Sustainability

There are two approaches to examine whether a groundwater source is sustainable. The first is a full fledged aquifer management plan approach similar to the one being employed near Yorkton, where extensive data collection and analysis defines the groundwater resources in great detail. However in the majority of cases, the lack of this detailed technical data and/or necessary resources precludes a broad and comprehensive understanding of the Basin groundwater resources, and thus precluded a proactive approach to management of the same. The regulatory process is designed to aid in managing groundwater in these instances for all non-domestic users. Through the approval process studies prior to using groundwater are done to give an initial determination that a use might be sustainable, followed by data collection after use to verify if the use is indeed sustainable.

- The goal of the Province is to continually improve the understanding of provincial groundwater resources so that Issues such as the sustainability of uses, artificial recharge, recharge areas, aquifer protection and, ultimately, supply can be comprehensively examined in each instance.

There is a lack of information regarding the groundwater resources in the Upper Assiniboine River Basin. Detailed investigations on the geology and hydrogeology in the watershed have not yet been conducted. Reports have been completed for groundwater works projects within the watershed. However, these reports are site specific to the project and may not identify recharge areas. The most extensive knowledge of the geology and available groundwater resources have been completed for aquifers surrounding the City of Yorkton. In 1999, SRC and SWA completed a study on the geology and groundwater resources for the watershed. Plan view and cross sectional maps were completed for the study. The study provided information on the general geology and hydrogeology at a regional scale. Small aquifers or aquifers that are near sustainable limits were not part of the study objectives.

The SRC and SWA observation well network are continually measuring certain aquifers through the watershed. Figure 1 illustrates the spatial distribution of the observation wells and Table 1 lists the depth and location of these wells. Detailed descriptions and hydrographs from the observation well network can be obtained from the SWA groundwater management website.

xx. The current and future ability to make good use of available water may be limited by the state or scale of the necessary infrastructure.

- This issue was not analyzed by the Technical Committee.

2005 Saskatchewan Watershed Authority

Assiniboine
River
Watershed

Preliminary Background Report Assiniboine River Watershed

Executive Summary

The Background Report is to provide basic watershed information to the planning participants to assist them in developing a source water protection plan. This plan is to protect both surface and ground source waters within the Assiniboine River watershed to ensure safe drinking water for the basin residents. This process addresses some of the original recommendations made during the Upper Assiniboine River Study, completed in 2001.

The report will provide information to enhance awareness of the many factors which affect both water quality and quantity the watershed. The basin is described in terms of its physical characteristics, ecology, land use, climate and population demographics. Major economic activities within the watershed include: agriculture, tourism and recreation, and industry.

Water resources are related in terms of quantity, quality, allocation and use. Current watershed source water questions include agricultural practices, municipal sewage effluents, landfill sites, storm water, well protection or integrity, well decommissioning, industries, chemical use and storage, drainage, and erosion.

The source water protection plan will be developed by the Assiniboine River Watershed Advisory committees with critical support from all watershed residents and in consultation with the technical committee. Planners with Saskatchewan Watershed Authority (SWA) will facilitate the planning process, which has a targeted two year completion date.

The focus of this plan, consistent with Saskatchewan's *Safe Drinking Water Strategy*, will be to protect source waters. The plan will assemble appropriate information, analyze threats and opportunities, build commitments to protect water, as well as summarize the committees' discussions and technical analysis in a number of recommendations and key actions required for an implementation strategy.

Key Watershed Facts:

- Within Saskatchewan, 17,300 km^2 in size
- Approximately 46,000 people (13,000 rural)
- 58% of the land cover is in cropland while 17% is in grassland and forages.
- Mean annual precipitation is 450 mm/year, with 27% as snowfall.
- Most stream flow occurs during April and May from snowmelt.
- Maximum annual discharge was 1,471,000 dams^3 in 1922. Mean annual discharge is 265,000 dams^3 (this equals about 15.6 mm of runoff from the whole basin)
- Major tributaries are Whitesand River, Yorkton Creek, Crescent Creek, and Lilian River.

In Partnership with...

Saskatchewan
Watershed
Authority

Acknowledgements

The development of the background report would not be possible without the contributions and efforts from the Technical Committee members and their agencies. Please refer to Appendix A for a list of Technical Committee members.

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http://www.swa.ca/Stewardship/WatershedPlanning/Default.asp?type=UAWS

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List of Abbreviations

ATC	Approval to Construct
ATO	Approval to Operate
CEAA	Canadian Environmental Assessment Agency
CEPA	Canadian Environmental Protection Act, 1999
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPR	Canadian Pacific Railway
DUC	Ducks Unlimited Canada
DFO	Department of Fisheries and Oceans Canada
EIA	Environmental Impact Assessment
IFN	Instream Flow Need
ILO	Intensive Livestock Operation
PFRA	Prairie Farm Rehabilitation Administration
RIB	Rapid Infiltration Basin
RM	Rural Municipality
SAFRR	Saskatchewan Agriculture, Food and Rural Revitalization
SARA	Species at Risk Act, 2002
SE	Saskatchewan Environment
SWA	Saskatchewan Watershed Authority
TDS	Total Dissolved Solids
WAC	Watershed Advisory Committee
WRL	Water Rights Licence
WQI	Surface Water Quality Index

1. Introduction

The development of a management strategy for a watershed normally begins with the assembly of basic watershed information into an overview or a background report. For the most part, the Upper Assiniboine River Basin (UARB) Study was utilized extensively to develop this background report. In addition, the Assiniboine River Basin Overview was also cited.

The background report will provide a current understanding and summary of the watershed for the planning process.

In October 1996, the Governments of Saskatchewan, Manitoba and Canada agreed to conduct a study of the Basin. The UARB Study was initiated as a result of the 1995 flood and other issues including drainage and flood control and the disappearance of valuable wetland habitat. In addition, there was uncertainty regarding sustainable water supplies for municipal, industrial, agricultural and recreational purposes and a lack of knowledge regarding the hydrologic and ecological processes and their effects at work within the Basin. There was also growing concern that the quality of water was deteriorating, and uncertainty about appropriate measures for aquifer management and protection. The UARB Study provided information respecting the Basin's water resources and information and recommendations on which to base decisions affecting future water management.

The formation of the Saskatchewan Watershed Authority and its mandate for source water protection initiated a series of watershed and aquifer planning processes within the Province. It was logical to select the Assiniboine River as one of the inaugural planning areas and to continue the original UARB efforts but with the stipulation of focusing on source water protection. In addition, this planning study will apply only to that part of the Assiniboine River Watershed located within the Province of Saskatchewan.

The background report will supply basic information to the local Watershed Advisory Committees, the Technical Committee and the general public about their watershed. Among the information to be detailed in this report are population and demographics, economic activities, land use, climate, physical characteristics, ground and surface water availability, water allocations, and wastewater disposal and treatment. Information about ecosystem health, including wetlands and riparian zones, and wildlife biodiversity will also be provided.

Real or perceived threats to source water will be presented. A summary of the challenges or issues will be included.

Ultimately, the source water protection plan will identify the threats to source waters and provide potential recommendations to address these threats.

2. Watershed Characteristics

2.1 Physical Characteristics

Physical Setting

The Assiniboine River Watershed encompasses an area of about 17,300 square kilometres in Saskatchewan. The basin is situated within two major physiographic regions; the Saskatchewan Plains and the Saskatchewan Uplands. (***Figure 1:* Physiographic Regions**). The former is comprised of the Assiniboine River Plain and the Quill Lake Plain physiographic units; the latter is represented by the Porcupine Hills Upland and the Touchwood Hills Upland. Most of the area is underlain by Cretaceous shales of the Riding Mountain Formation up to 300 metres (m) thick.

The Assiniboine River was formed between 14,000 and 12,500 years ago by meltwater from the retreating Wisconsin continental glacier (Christiansen 1979, Assiniboine River Basin Overview).

Geography

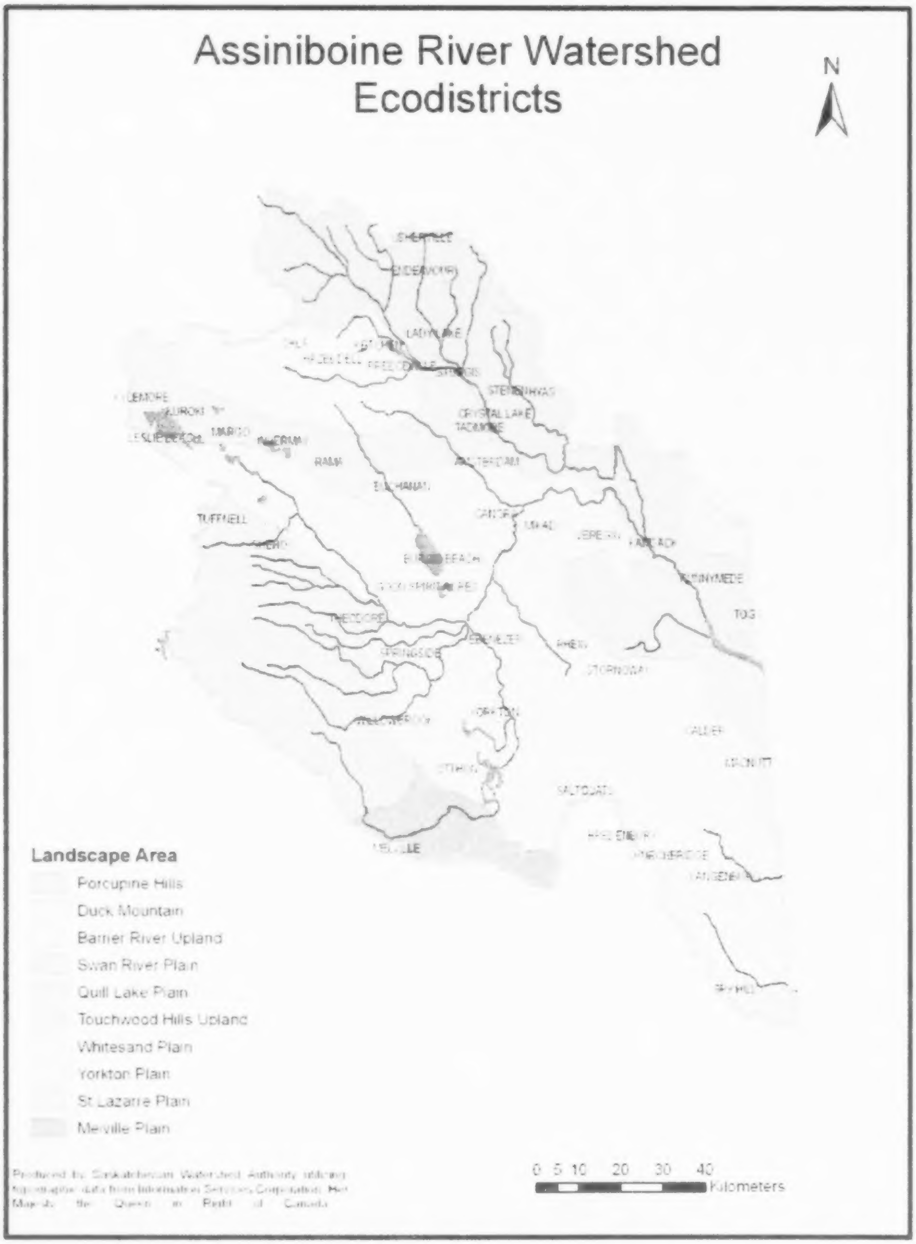
The Assiniboine River and its tributaries drain areas in eastern Saskatchewan and western Manitoba. The Assiniboine River Watershed covers an area of 17,300 square kilometres in Saskatchewan and includes 24 rural municipalities, 8 towns, 15 villages and the cities of Melville and Yorkton, (***Figure 2: Admin Boundaries***).

The major tributaries include the Qu'Appelle River, which joins the Assiniboine at St. Lazare, Manitoba and the Souris River, which joins east of Brandon, Manitoba. The Assiniboine River terminates at the Red River in Winnipeg.

The headwaters of the Assiniboine River are about 50 kilometres (km) northwest of Preeceville in the Porcupine Hills. The Whitesand River, which rises out of the Beaver Hills northwest of Yorkton, joins the Assiniboine River near Kamsack. Other major Saskatchewan tributaries are the Lilian River and Yorkton Creek. Several natural lakes are found in the Basin, most notable of which are Good Spirit Lake, Fishing Lake, and the series of small, interconnected lakes south of Yorkton, which include York, Roussay, Leech, and Crescent Lakes.

The Assiniboine River then continues southeast for another 45 km before entering Manitoba. Shellmouth Dam is located on the Assiniboine River, 35 kilometres downstream of the provincial boundary. The dam creates Lake of the Prairies, a 56 km long reservoir that extends into Saskatchewan.

Figure 1: Physiographic Regions


Assiniboine River Watershed
Ecodistricts
N
ENDEAVOUR
LADY LAKE
HAZEL DELL
PREECEVILLE
STURGIS
CRYSTAL LAKE
TADMORE
AMSTERDAM
LESLIE BEACH
MARGO
RAMA
BUCHANAN
TUFFNELL
CANORA
MIKADO
VEREGIN
KAMSACK
RUNNYMEDE
TOGO
BURGIS BEACH
GOOD SPIRIT ACRES
THEODORE
EBENEZER
RHEIN
SPRINGSIDE
STORNOWAY
YORKTON
WILLOWBROOK
CALDER
MACNUTT
SALTCOATS
MELVILLE
BREDENBURY
LANGENBURG
SPY HILL
Landscape Area
Porcupine Hills
Duck Mountain
Barrier River Upland
Swan River Plain
Quill Lake Plain
Touchwood Hills Upland
Whitesand Plain
Yorkton Plain
St Lazarre Plain
Melville Plain
0 5 10 20 30 40
Kilometers

Produced by Saskatchewan Watershed Authority utilizing topographic data from Information Services Corporation, Her Majesty the Queen in Right of Canada

Figure 1: Physiographic Regions

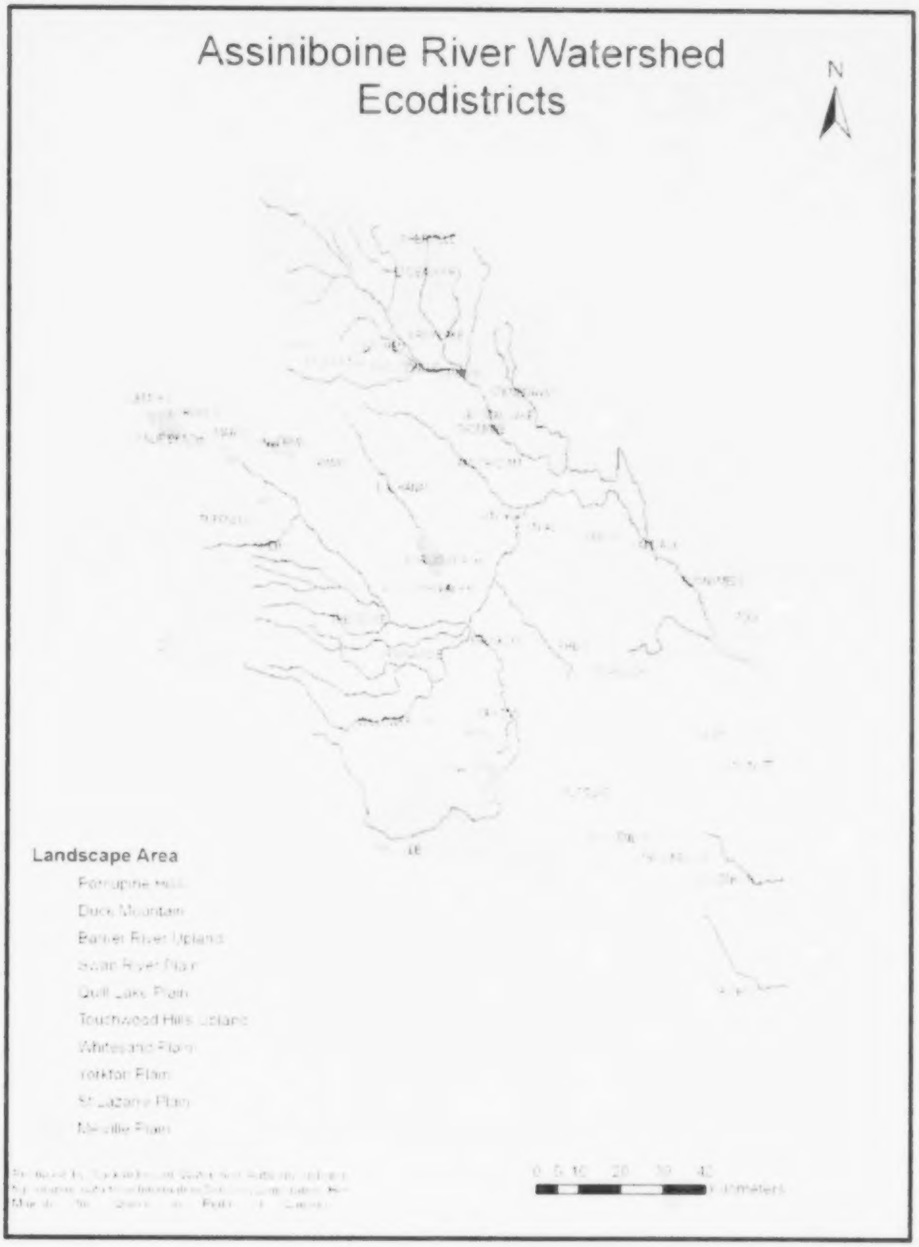

Assiniboine River Watershed Ecodistricts
N
Landscape Area
Porcupine Hills
Duck Mountain
Barrier River Upland
Swan River Plain
Quill Lake Plain
Touchwood Hills Upland
Whitesand Plain
Yorkton Plain
St. Lazare Plain
Melville Plain
0 5 10 20 30 40
Kilometers

Figure 2: Admin Boundaries

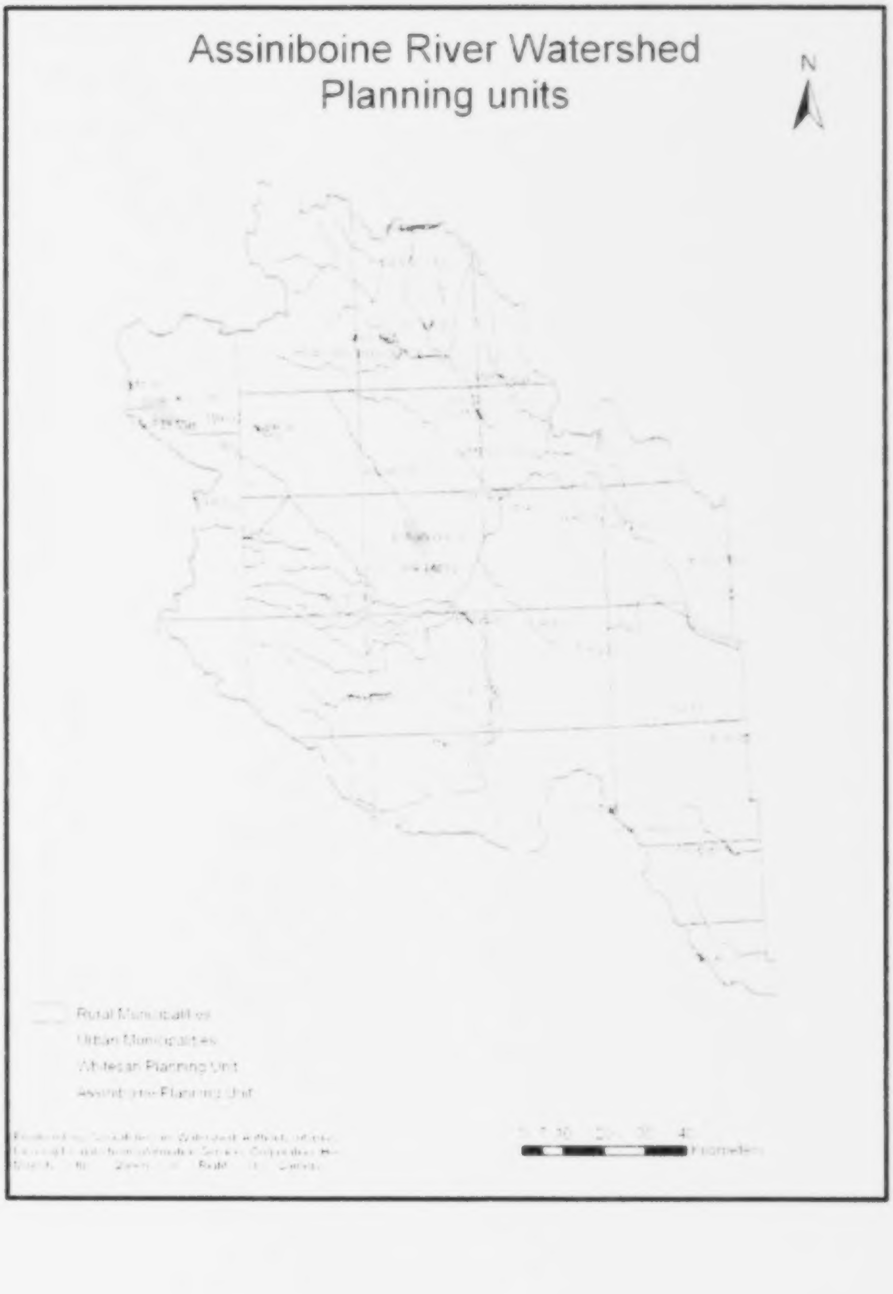
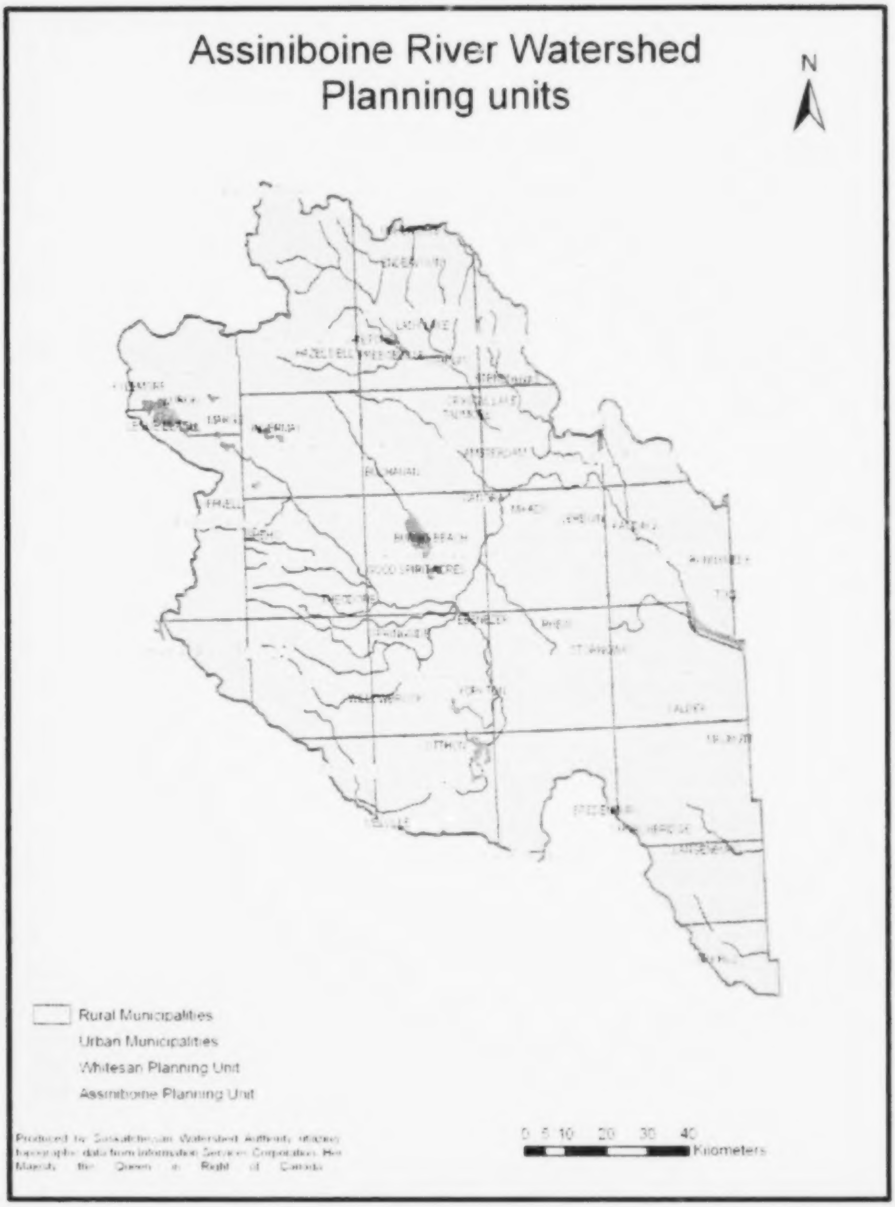

Assiniboine River Watershed
Planning units
N
Rural Municipalities
Urban Municipalities
Whitesand Planning Unit
Assiniboine Planning Unit
0 5 10 20 30 40
Kilometers

Figure 2: Admin Boundaries


Assiniboine River Watershed
Planning units
N
BUCHANAN
Rural Municipalities
Urban Municipalities
Whitesan Planning Unit
Assiniboine Planning Unit
0 5 10 20 30 40
Kilometers

Produced by Saskatchewan Watershed Authority utilizing topographic data from Information Services Corporation. Her Majesty the Queen in Right of Canada.

Topography

The topography is gently to moderately undulating, with the higher relief evident in the southwestern portion of the Basin. Surficial sediments are primarily glacial till that is deeply incised by spillways and meltwater channels. The slopes of this region vary depending upon the geology of the area (***Figure 3: Slope Classification***). Areas in the Touchwood Hills Uplands and Porcupine Hills Uplands, as well as those directly adjacent to the Assiniboine River below Kamsack, are the steepest. ***Figure 4***, a digital elevation model of the watershed, shows the steeper slopes along the Assiniboine and the level topography of the Assiniboine Plains throughout most of the watershed.

Figure 3: Slope Classification

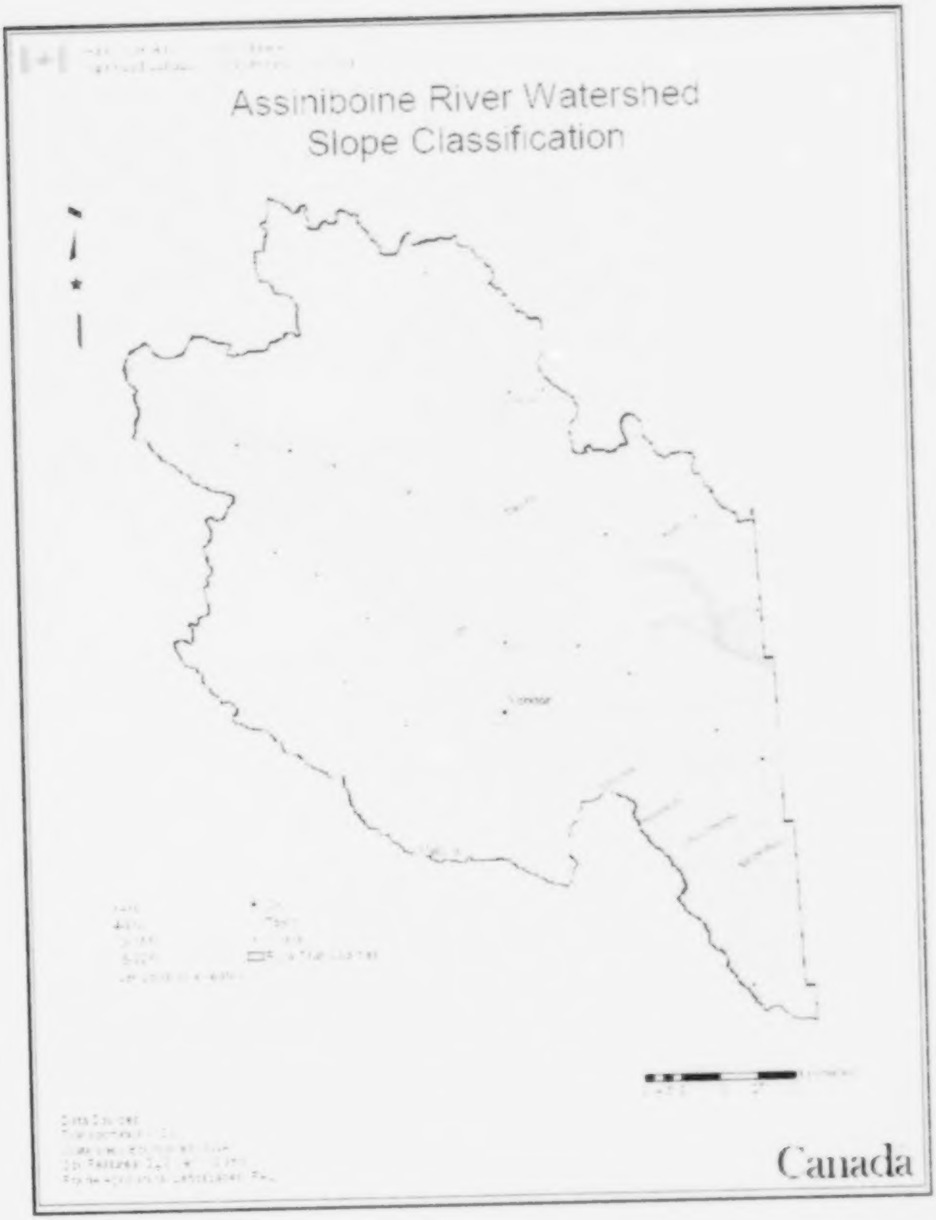

Assiniboine River Watershed
Slope Classification
Canada

Figure 4: Digital Elevation Model

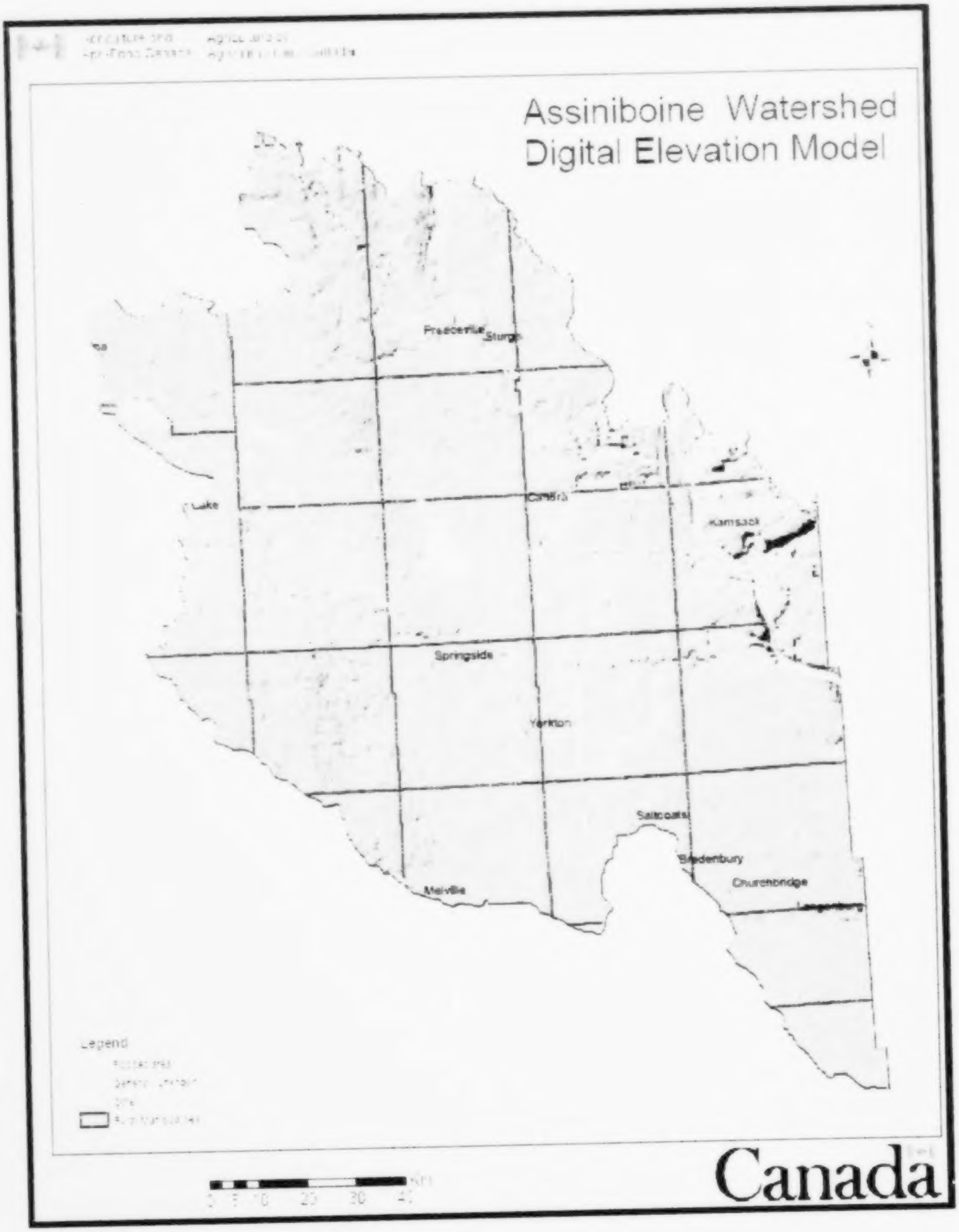

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine Watershed
Digital Elevation Model
Preeceville
Sturgis
Lake
Canora
Kamsack
Springside
Yorkton
Saltcoats
Bredenbury
Churchbridge
Langenburg
Melville
Legend
0 5 10 20 30 40
km
Canada

Figure 3: Slope Classification

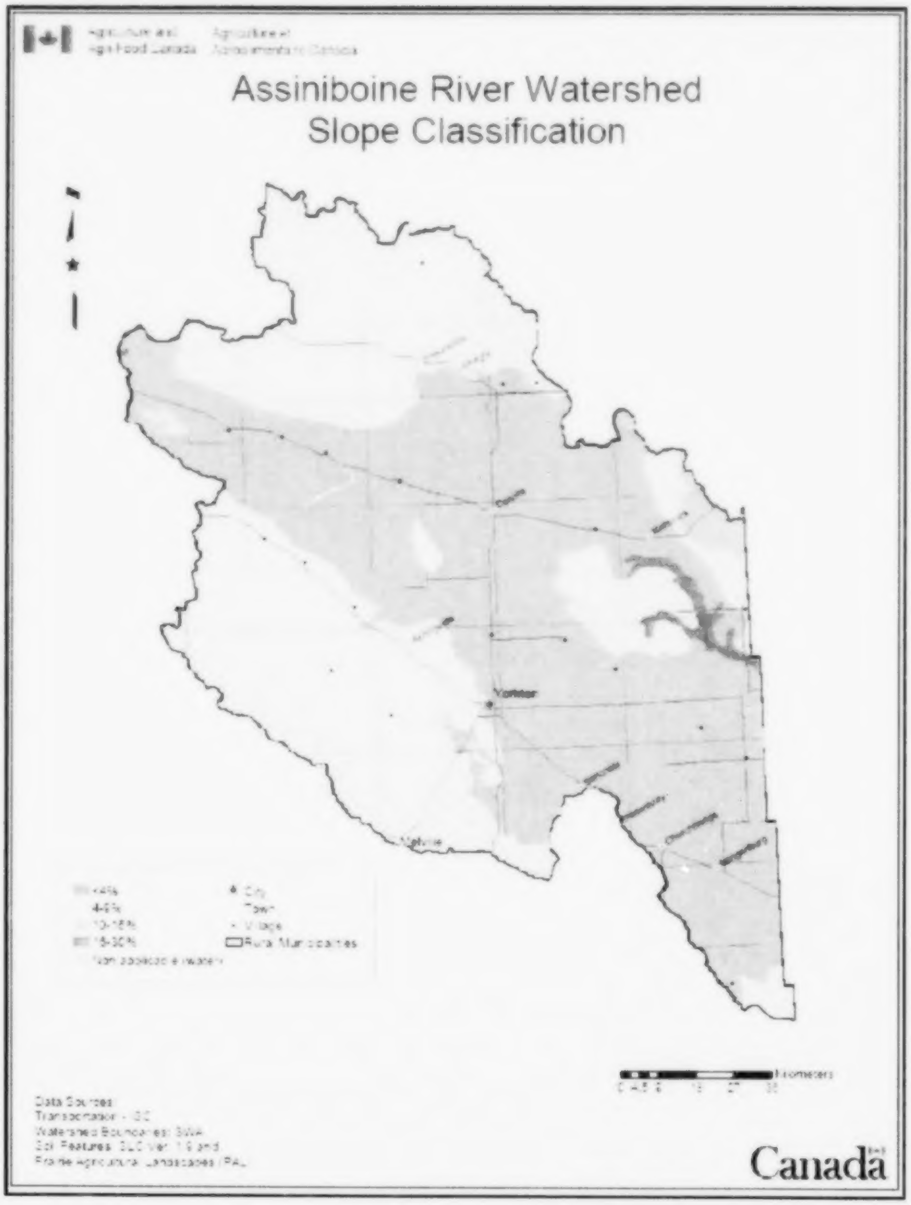
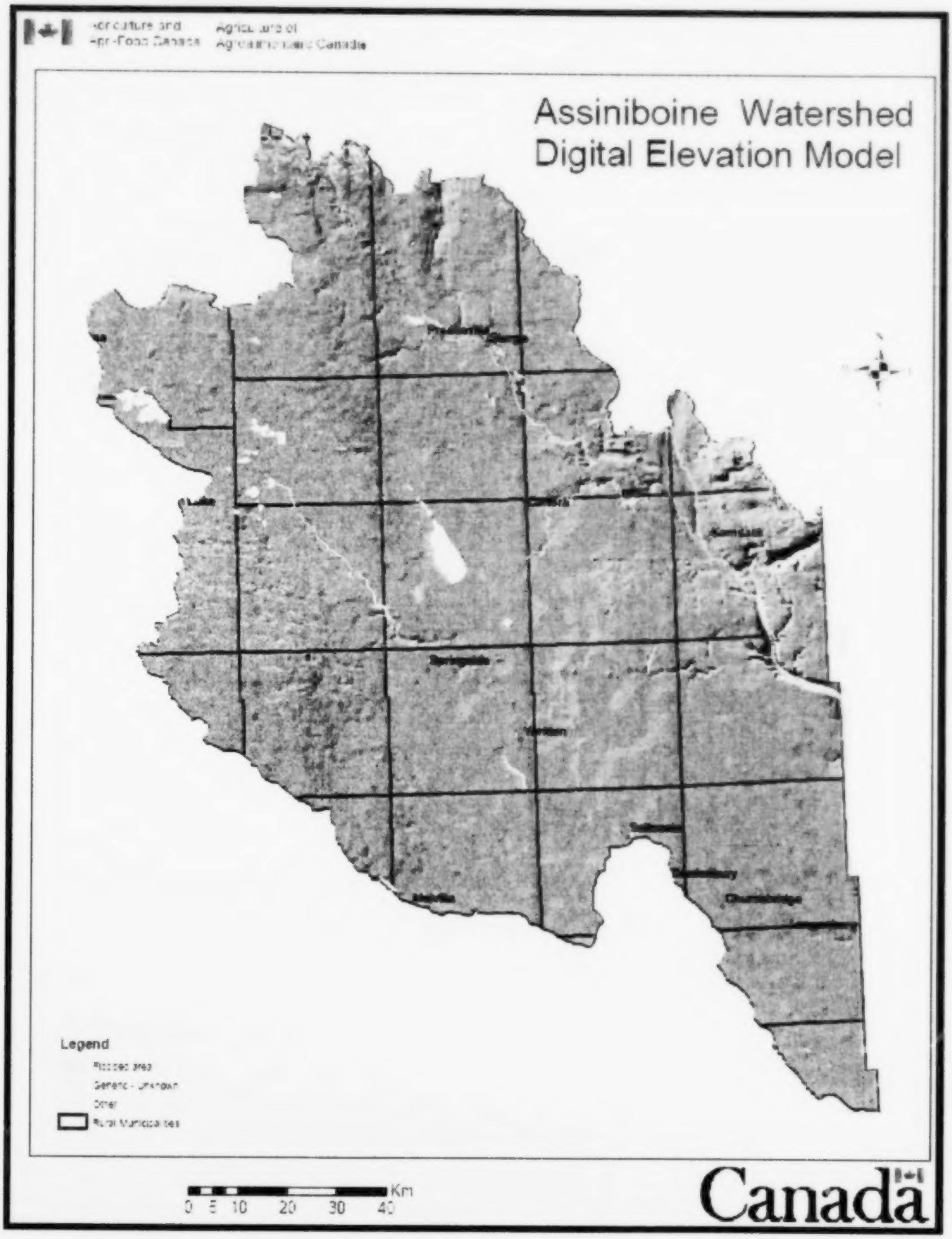

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine River Watershed
Slope Classification
Yorkton
Melville
<4%
4-9%
10-15%
15-30%
Non applicable (water)
City
Town
Village
Rural Municipalities
Kilometers
Data Sources:
Transportation - IGC
Watershed Boundaries: SWA
Soil Features: SLC ver. 1.0 and
Prairie Agricultural Landscapes (PAL)
Canada

Figure 4: Digital Elevation Model


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine Watershed
Digital Elevation Model
Legend
Flooded area
Generic - Unknown
Other
Rural Municipalities
0 5 10 20 30 40
Km
Canada

Soils

Black chernozemic soils overlay almost 70 percent of the Basin. These soils are high in organic matter and have generally developed under native grassland vegetation. In the northern and southwestern portions of the Basin, the black soils have been modified to dark grey and grey chernozemic and luvisolic soils. Regosolic soils generally occur in river valleys and adjacent to Basin lakes. These soils are light-coloured, lack distinct horizons and are highly fertile as a result of alluvial deposition during periodic flood events. The original natural vegetation of the area was native grassland interspersed with groves of aspen or occasionally oak. Most of the grasslands have been cultivated but many of the aspen groves remain.

Soil Texture

Soils in the Assiniboine River Watershed are distributed as shown in ***Figure 5: Surface Texture***. Soil texture plays an important role in the ability of a soil to bind nutrients and contaminants, and to retain moisture. Soil texture is an indication of the proportion of various sizes of sand, silts and clays, with sand having the largest particle size. Sandy soils are usually loose, well drained, well aerated, easy to cultivate, and often not very productive. Soils with a higher proportion of clays tend to absorb and retain more water making them sticky when wet. They are also tight and cohesive when dry which make them more difficult to cultivate. Clay soils have a large active surface area which can bind and hold nutrients, contaminants and bacteria (Hillel, 1982).

Erosion

Erosion is caused by the movement of soil particles by wind or water. The loss of sediment is detrimental to the productivity of a soil because of the removal of organic matter, the breakdown of soil structure and the removal of fine soil particles. Because soil particles can bind with nutrients, chemicals and microorganisms, transport by erosion can act as a conduit for contaminants to reach surface waters. This aspect is especially critical to the transport of phosphorous.

The most important factor in preventing soil erosion is the maintenance of a vegetative cover.

The amount and intensity of erosion is dependent upon many factors. Some of these include:

> Vegetation: The type and amount of vegetative cover is important in controlling erosion. Streambank and instream vegetation will slow the water flow resulting in less erosion. Riparian vegetation is water tolerant and usually consists of thick dense brush, trees, or grasses, the roots of which binds the soil together and help to stabilize the banks. Riparian vegetation also functions as a filter to stop sediment, nutrients and contaminants from entering the stream. Its roots act to bind and hold the soil particles together. Vegetation located directly in the water helps to slow water speed while protecting stream banks. On fields with little or

no vegetation, rainwater will hit the bare soil with full force. Vegetation intercepts and slows raindrops so the impact force is reduced. This prevents the soil particles from separating and breaking apart. Vegetation will also slow down runoff, act as a filter, and trap sediment and any contaminants that are being transported.

Texture: Clays have the ability to bind and pack closely together. They also tend to have a higher concentration of organic matter. Therefore, clay soils are more difficult to erode. Generally, soils which are low in organic matter, with a high percent of silt and very fine sands, are more erodible.

Management, Tillage Practices: High disturbance tillage results in decreased organic matter by exposing the buried organic matter to decomposition. Tillage also disrupts the soil aggregates and physical structure by breaking the aggregates into smaller particles, thereby making the soil more prone to erosion. Zero tillage practices, on the other hand, result in minimal soil disturbance, reduced erosion and increased infiltration that replenishes soil moisture.

Slope: The slope of the land plays an important role. Long steep slopes will have the greatest amount of erosion.

Rainfall intensity: The intensity of the rainfall event and the amount of runoff generated will influence the amount of soil being eroded.

Speed of the water flow: Higher water flow velocity will have a greater impact on streambank erosion than slower flows. The speed of the water flow also controls how much potential sediment the stream can carry. This is called the sediment load. The faster the stream moves, the more potential sediment it can carry with it. As the flow velocity slows down, this sediment is then deposited.

Snowmelt is a special situation of water moving across the land. Erosion can be very significant if the soils are thawed, depending on cover, slope, texture, and tillage practice.

There are three common types of erosion; water, wind and bank.

Water erosion

Water erosion begins with rain drops hitting the soil surface causing the soil particles to break into smaller pieces. These soil particles can then be easily transported, carrying with it any attached chemicals and nutrients. The sediment, along with the chemicals and nutrients, may reach a water system or be deposited elsewhere in the watershed.

Snowmelt can also contribute to significant erosion via surface runoff if the conditions are ideal.

Some portions of the Assiniboine River Watershed are classified as having a high risk for water erosion, indicating that rapid soil loss will occur unless conservation practices are initiated (***Figure 6: Water Erosion Risk***). Moderate risk areas indicate that conventional cropping practices will result in a steady loss of soil by water erosion. In areas having moderate to high-risk potential, conservation practices such as reduced or zero tillage should be used to reduce erosion and land degradation.

Wind erosion

The third type of erosion is wind erosion. Although not directly connected to water, sediment may be deposited directly in water bodies or ditches by wind, where it will be susceptible to water erosion.

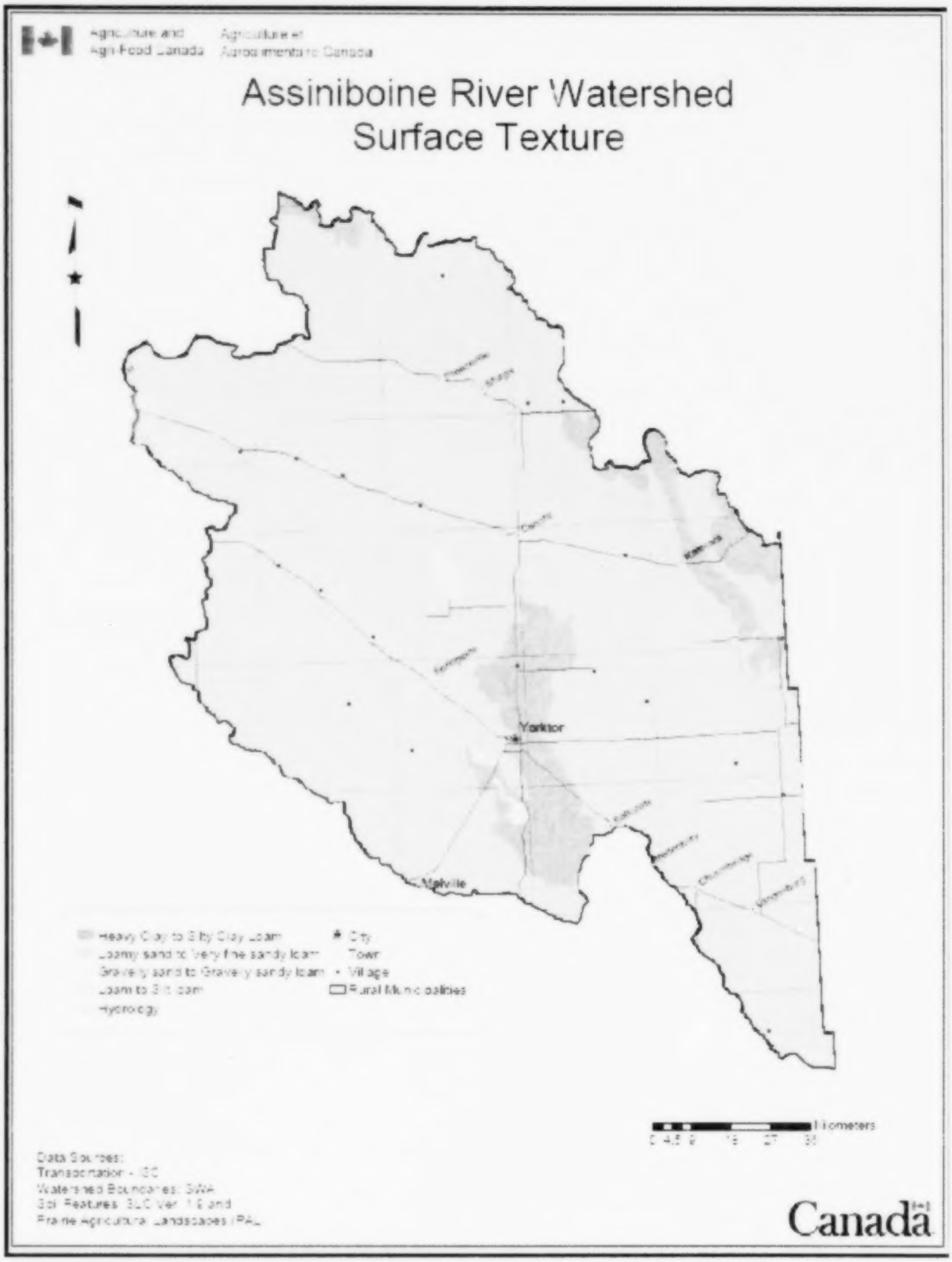
Generally, the Assiniboine River Watershed is classified as having a very low risk to wind erosion, with the exception of areas along the Assiniboine River and at the upper reaches of the Whitesand River towards Fishing Lake, Figure 7: Wind Erosion Risk. Soils that are susceptible to erosion can be secured with landcover. Areas of moderate wind erosion show that average growing conditions may not generate enough surface residues to protect the soils from wind erosion. Practices such as direct seeding or zero tillage would be more beneficial in these areas.

Bank erosion

Bank erosion from water movement in streams is a natural process that may be amplified by agricultural practices such as cultivation or overgrazing. For example, the vegetation in the riparian flood plain area helps to slow down water and trap sediment. If this area is cultivated then the water speed will be greater, causing an increase in erosion.

Banks along the Assiniboine River and its tributaries have not been assessed for erosion. although Saskatchewan Watershed Authority field staff feel that along the main stems, generally speaking, bank erosion is not a widespread concern.

Figure 5: Surface Texture


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine River Watershed
Surface Texture
Yorkton
Melville
Heavy Clay to Silty Clay Loam
Loamy sand to Very fine sandy loam
Gravelly sand to Gravelly sandy loam
Loam to Silt loam
Hydrology
City
Town
Village
Rural Municipalities
Kilometers
0 4.5 9 18 27 36
Canada

Data Sources:
Transportation - ISC
Watershed Boundaries: SWA
Soil Features: SLC Ver. 1.0 and
Prairie Agricultural Landscapes (PAL

Figure 5: Surface Texture

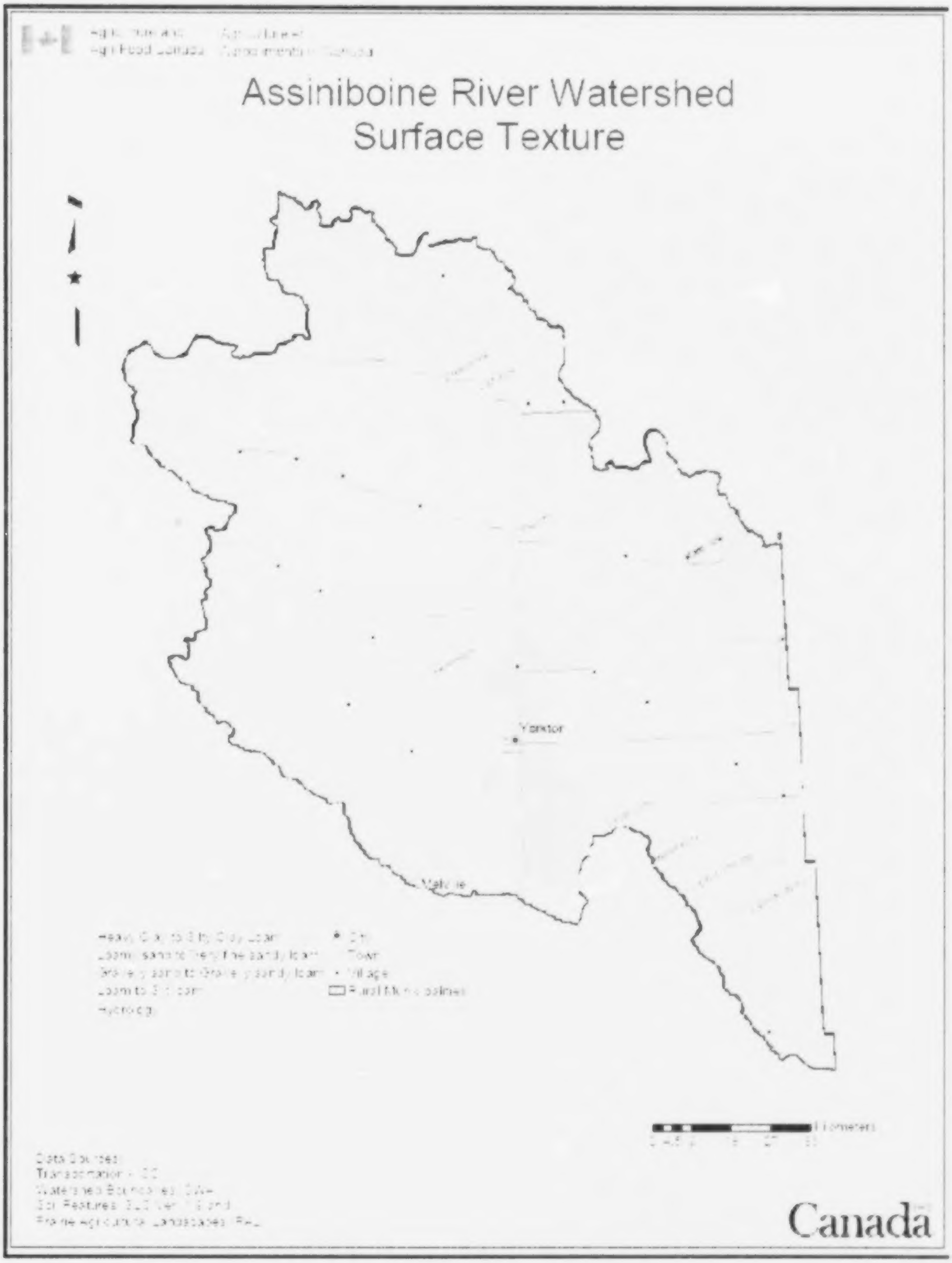
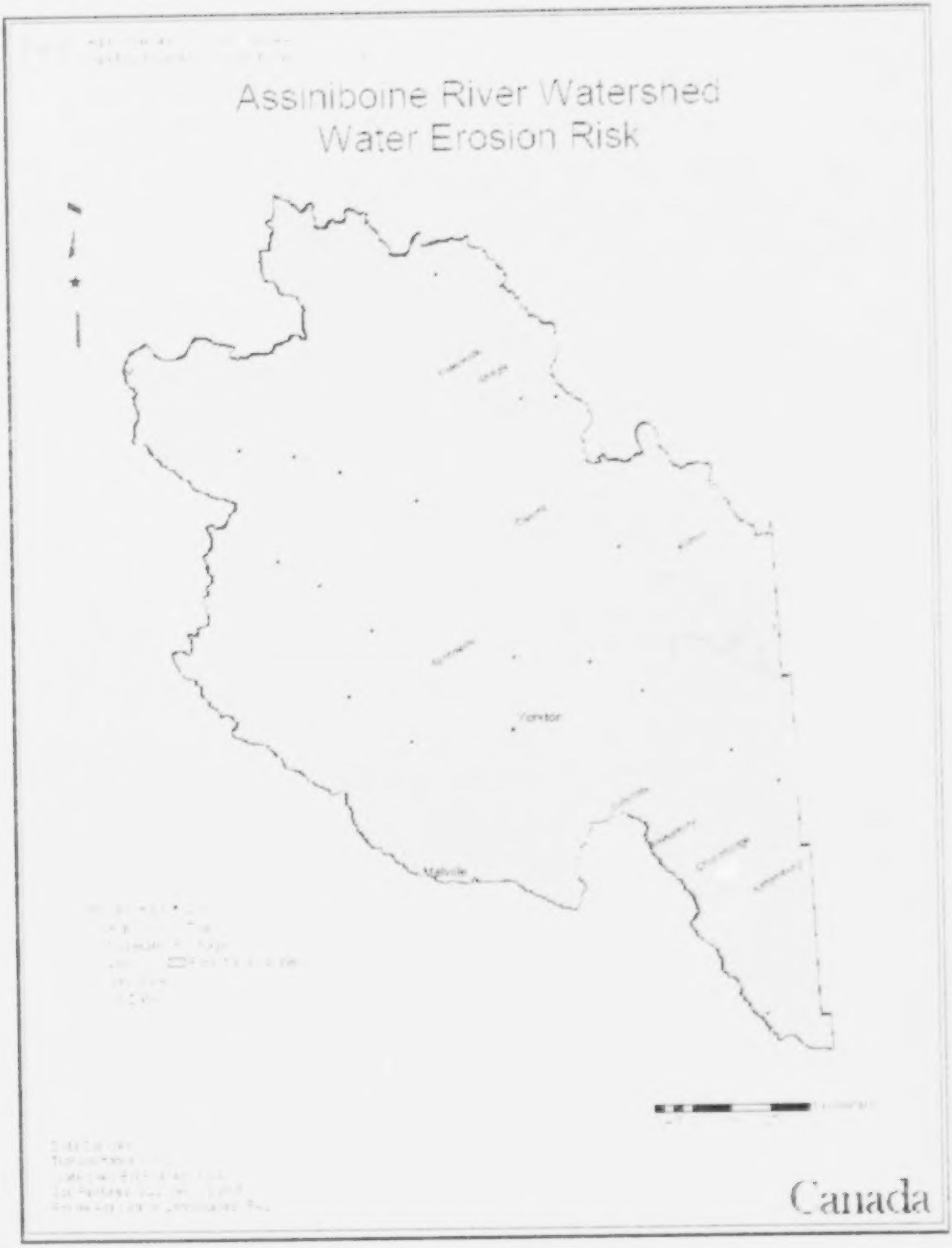

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine River Watershed
Surface Texture
Yorkton
Melville
Heavy Clay to Silty Clay Loam
Loamy sand to Very fine sandy loam
Gravelly sand to Gravelly sandy loam
Loam to Silt loam
Hydrology
City
Town
Village
Rural Municipalities
Kilometers
Data Sources
Canada

Figure 6: Water Erosion Risk



Assiniboine River Watershed
Water Erosion Risk
Yorkton
Melville
Canada

Figure 7: Wind Erosion Risk

Assiniboine River Watershed
Wind Erosion Risk
Yorkton
Canada

Figure 6: Water Erosion Risk

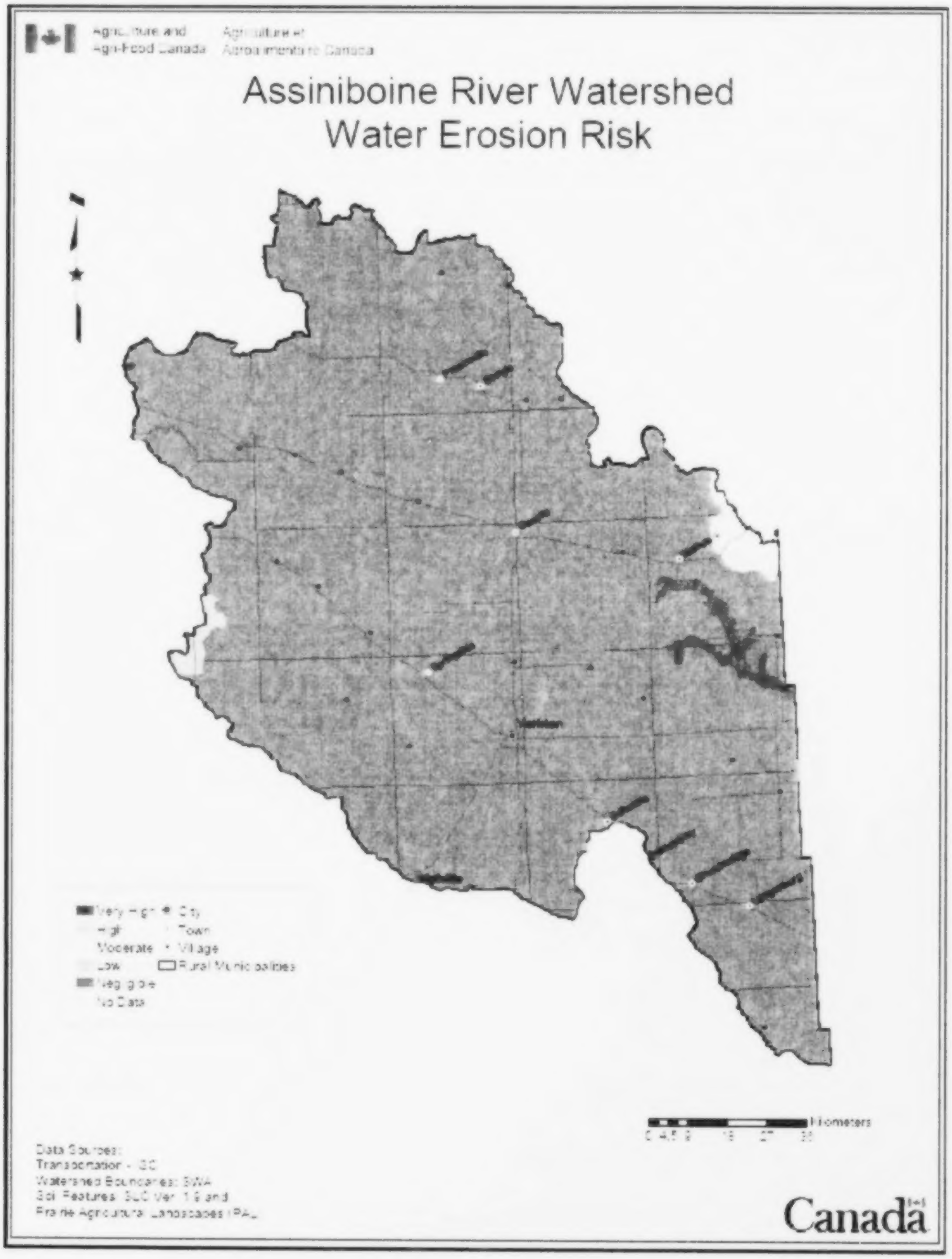
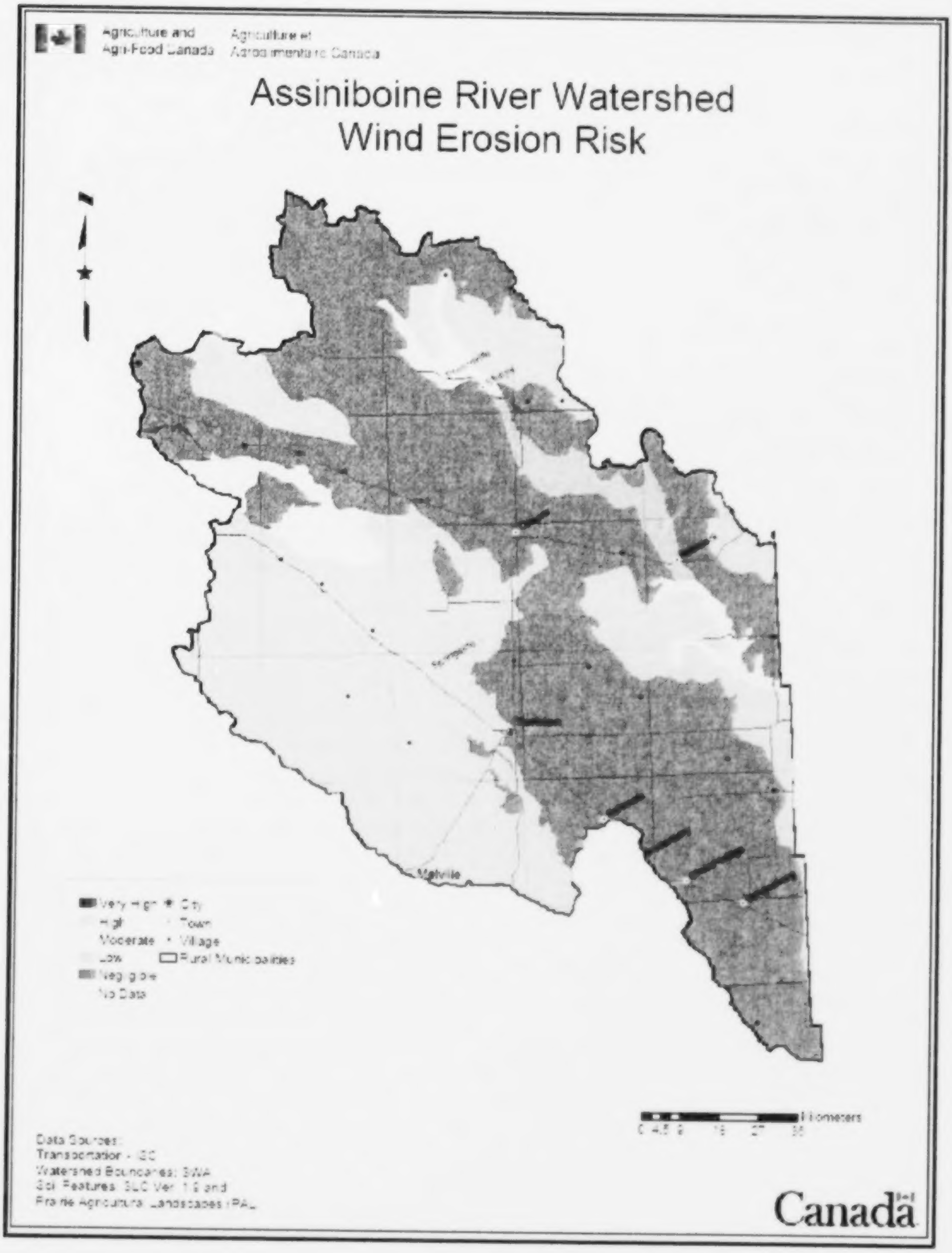

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine River Watershed
Water Erosion Risk
Very High
City
High
Town
Moderate
Village
Low
Rural Municipalities
Negligible
No Data
0 4.5 9 18 27 36
Kilometers
Data Sources:
Transportation
Watershed Boundaries: SWA
Soil Features: SLC Ver. 1 and
Prairie Agricultural Landscapes (PAL
Canada

Figure 7: Wind Erosion Risk


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Assiniboine River Watershed
Wind Erosion Risk
Melville
Very High
High
Moderate
Low
Negligible
No Data
City
Town
Village
Rural Municipalities
0 4.5 9 18 27 36
Kilometers
Data Sources:
Transportation - ISC
Watershed Boundaries: SWA
Soil Features: SLC Ver. 1.0 and
Prairie Agricultural Landscapes (PAL
Canada

2.2 Ecology

Wildlife

The Upper Assiniboine River Basin supports a diverse wildlife population. The Basin supports about 240 bird species, 50 mammal species, three reptile and five amphibian species.

White-tailed deer are the most common ungulate, inhabiting the hills, valleys and aspen bluffs. Elk and moose are less common. Other types of wildlife commonly found include bear, muskrat, beaver, skunk, badger and gopher.

Included in the area's diverse bird population are endangered species identified by the Committee on the Status of Endangered Wildlife in Canada, an independent body with provincial and federal government representation. The organization has identified the loggerhead shrike, burrowing owl, Baird's sparrow and ferruginous hawk as threatened species, all of which are residents of the Study area.

Several species of wildlife which are vulnerable because of their localized breeding distribution occur within the watershed. These include the black-crowned night heron, American bittern, sandhill crane, yellow rail, Franklin's gull, common tern, Forster's tern, and black tern, which utilize wetlands and lakes for breeding and foraging. The yellow-throated vireo and golden-winged warbler may occur in small numbers in woodlands in the eastern portion of the watershed. The red sided garter snake may occur along the major waterways and forage in riparian habitat and adjacent wetlands.

Waterfowl and upland game are widespread. Habitat in the pothole region in the western areas is particularly good for waterfowl. Ruffed and sharp-tailed grouse are also common.

The watershed is an important breeding area for waterfowl in prairie Canada. The diversity of wetlands types, abundance of more permanent wetlands, and more stable water conditions compared to more southerly regions, allow for more consistent waterfowl production. Seven species of dabbling ducks breed within the watershed. The mallard and blue-winged teal are most abundant. Seven species of diving ducks breed within the watershed. The lesser scaup, canvasback, redhead and ruddy ducks are the most abundant. Dabbling ducks are much more abundant than diving ducks. Total ducks within the watershed varied from approximately 200,000 in the dry late 1980s to over 800,000 in the late 1970s when water conditions were good.

Signed in 1986, the North American Waterfowl Management Plan (NAWMP) is an international agreement between the federal governments of Canada, USA, and Mexico to restore and maintain continental waterfowl populations to the average levels observed in the 1970s. The means to accomplish this goal is through habitat protection, conservation and restoration, and through modification of agricultural practices to become more wildlife-friendly while economically and agronomically beneficial for producers. While waterfowl are the target species for much NAWMP activity, the mandate has broadened to include multi-species benefits. The benefits to society from habitat conservation are numerous and include water conservation and purification, biodiversity, and recreation opportunities. The NAWMP has identified the prairie pothole region (PPR) of prairie Canada and the northern USA as the most important breeding habitat for waterfowl in North America.

According to LANDSAT satellite imagery (1994), wetlands covered 250,000 hectares (617,5 00 acres). The estimated number of wetland basins with surface water in early May has varied from approximately 350,000 in drier springs, to approximately 700,000 in wet springs (Canadian Wildlife Service and United States Fish and Wildlife Service aerial surveys). The most common wetlands are temporary wetlands (33 percent) and seasonal wetlands (53 percent). However, many of these may be dry in years with poor spring runoff.

The distribution of wetlands varies throughout the Basin. Relatively fewer wetlands occur in the northwest portions of the Basin between Buchanan and Fishing Lake, in the northern portion of the Basin just north of Sturgis, and in some areas immediately east of Lake of the Prairies. Greater numbers of wetlands occur in the areas along the northern edge of the Basin, south of Yorkton, and from Wroxton to the southern edge of the Basin. The reasons for differences in wetland distribution are related to topography, slope aspect, local climate and soil characteristics. In addition, human activities have impacted wetland distribution through activities such as land drainage and wetland consolidation.

Within the Basin the most abundant upland cover is cropland (69 percent), followed by woodland (13 percent), native grassland (eight percent) and native grassland used for pasture (seven percent). Hayland is relatively uncommon (three percent). (Source: Canadian Wildlife Service Ground Survey)

The distribution of native vegetation varies. Significant areas of wooded vegetation occur along the Assiniboine River valley, in the forest fringe along the northern portion of the Basin north and west of Lady Lake, and in the region between Good Spirit Lake and Fishing Lake. Aspen groves are found throughout the Basin. Larger areas of native grasslands and shrubs are located in the western part of the Basin in the Beaver Hills and along the Whitesand River.

Fish

The Upper Assiniboine River Basin has a diverse fish community, with established populations of 32 species of fish (***Appendix B***). Common species include northern pike, walleye, perch, burbot, mooneye and rock bass. Four members of the sucker family are present, including white sucker, quillback, silver redhorse and shorthead redhorse. Two members of the catfish family, the brown bullhead and the stonecat, are present. In addition, eighteen species of smaller fish belonging to the minnow and stickleback families and the darter subfamily are also found in the Basin.

A small member of the lamprey family, the chestnut lamprey, has been collected at several locations in the Basin. This species spends several years as an inactive larva in the bed of streams followed by about 18 months as a predatory adult. The chestnut lamprey is listed as vulnerable by the Committee of Endangered Wildlife in Canada. This listing means that the species is not in current danger but is of special concern due to characteristics that make it sensitive to human activities or natural events.

All the species listed in ***Appendix B*** are native species with the exception of the common carp which invaded the Assiniboine River Watershed sometime after its introduction to North America from Europe. Several non-native trout species are stocked in smaller lakes in the Basin. Populations of these species typically are not self-sustaining and must be maintained by continued stocking programs.

Most harvest of fish in the Assiniboine River Watershed is by recreational fishermen. Information derived from sport fishing surveys in 1990 and 1995 (Joerissen and Brickley 1998; Carl Wall, Manitoba Conservation, pers. comm.) indicates that approximately 150,000 angler days of fishing effort are expended annually in the Basin. The total angling harvest in the Basin is estimated at 285,000 fish per year, consisting mainly of northern pike, walleye and perch.

The estimated angling effort in the Upper Assiniboine River Basin is about 3 percent of the total combined angling effort for the provinces of Manitoba and Saskatchewan. Angling harvest in the Basin is about 2 percent of the total combined angling harvest for the two provinces. The harvests are relatively small in comparison to provincial totals but several locally important angling waters occur in the Basin, including Lake of the Prairies, Good Spirit Lake and Fishing Lake.

Several bait fishing licences are issued annually in the Basin. Minnow species such as spottail shiner and emerald shiner are harvested and preserved for resale to anglers. Most production originates from Lake of the Prairies with annual harvests of about 12,000 kg/year on the Manitoba side of the border (Bruce Wright, SERM, pers. comm.) and about 1,000 kg/year on the Saskatchewan portion of the lake (Tom Maher, SERM, pers. comm.)

Domestic harvest of suckers occurs at several locations in the Basin. Typically, suckers are dip-netted during the spring spawning run. Depending on spring conditions, up to several dozen licences may be issued annually in Saskatchewan with harvests of up to a few thousand kilograms.

Fish Habitat

Fish habitat is defined under the *Fisheries Act (Canada)* as the "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes." In effect, almost any aquatic area to which fish have access is fish habitat.

Habitat requirements vary according to fish species, life stage and time of year. For example, species such as walleye and white suckers require clean gravel and cobble in streams or along windswept lake margins. Northern pike require shallow, vegetated areas in marshes or flooded terrestrial grasses along the margins of lakes or streams for spawning purposes. Nursery areas for many species of fish are typically shallow, vegetated areas that provide abundant food and cover from predators. Larger fish seek deeper water for feeding during the summer growing period and require permanent, deep water bodies for overwintering.

Nonpermanent wetlands are often important fish habitat. For example, seasonally inundated marshes and hay flats bordering lakes and streams provide valuable spawning areas for pike and perch. A water body need not contain fish species of economic importance for it to constitute fish habitat. For example, streams or marshes supporting only minnow species or aquatic invertebrates may be considered to be fish habitat since these areas provide a food supply for other fish species.

Since fish need different types of habitat during different life stages and at different times of year, the migration routes connecting these habitat types are of critical importance to the survival of fish populations.

The value of aquatic habitat in lakes and large rivers is easily recognized. Other kinds of habitat are less obvious but may be equally important in aquatic systems. Small, semi-permanent streams often support only a limited number of fish species but population densities in these streams can be very high. Such streams can contribute large amounts of forage fish and invertebrates to larger, downstream water bodies (Zale *et al.* 1989). In the Assiniboine River Basin, many small streams flow only in the spring and early summer. In addition to producing forage fish, these small, intermittent streams can be important spawning habitat for larger fish species such as northern pike, provided that flows persist long enough in the spring to allow successful downstream movement of the newly hatched fry. A study in Ontario found that the downstream drift of fish fry in an intermittent stream was comparable to drift in an adjacent perennial stream, suggesting that intermittent streams may be important nursery areas (Dance and Hynes 1979, in Zale *et al.* 1989). Small streams greatly outnumber large streams in a watershed (Gordon *et al.* 1992), therefore, small streams contribute relatively large numbers of forage fish and young-of-the-year fish to downstream lakes and rivers.

Water bodies in the Assiniboine River Basin that are of particular importance to fish include many of the larger lakes such as Good Spirit and Fishing lakes. These lakes typically contain a variety of species, including those actively sought by anglers, such as northern pike, walleye and perch. Lake of the Prairies, a man-made reservoir, supports the largest sport fishery in the Basin. The main stem Assiniboine River and Whitesand River both provide year-round habitat for fish (Al McCutcheon, SERM, pers. comm.). Numerous species of fish, including pike and walleye, have been collected as far upstream as Rockford on the Assiniboine River and the Theodore Dam on the Whitesand River. Tributary streams of these rivers, such as Yorkton Creek, Crooked Hill Creek, Wallace Creek and Stony Creek (near Stenen), support spawning runs of northern pike. Spawning runs of both northern pike and walleye occur in Spirit Creek, which flows into Good Spirit Lake. Even smaller tributary streams in the Basin have been found to support a variety of forage fish species, and in some cases, function as spawning areas for northern pike.

A variety of human activities have had an impact on fish and fish habitat in the Assiniboine River Basin. Construction of dams, weirs and road crossings has resulted in complete or partial blockages of fish migrations at several locations in the watershed. Unrestricted movement throughout a river system is important to the overall health of fish populations. Different types of habitat required at different stages of a fish's life cycle may occur considerable distances apart. For example, fish may overwinter in a large lake or river but suitable spawning areas may be located as much as one hundred kilometers or more upstream. Without free access to the upstream spawning areas, the population may be reduced in abundance. Since fish often travel great distances for spawning, the existence of a barrier on part of a river can have impacts on fish populations in lakes or rivers considerable distances downstream.

Dams typically form complete barriers to fish migration, unless equipped with fishways. Weirs may constitute complete barriers in low water years but may be overtopped by flood waters during periods of high runoff, reducing impacts to fish migration. Only one water control structure in the Assiniboine River Basin, the Kamsack Weir, is equipped with a fishway. The existence of dams in the Assiniboine River Basin may have had beneficial side effects by helping to restrict the spread of invasive species such as the common carp.

Road crossings of streams have potential to block upstream movements of fish. Undersized culverts result in excessive water velocities within the culvert, and fish are unable to proceed upstream through the culvert. In addition, improperly installed culverts may result in waterfalls at their downstream ends which form physical barriers to fish passage. As with dams and weirs, the main impact of substandard road crossings is disruption of upstream spawning migrations.

2.3 Land Use

The dominant land use of the watershed is agriculture, with 58 percent of the agricultural land used for annual crops (***Table 1: Land Cover***).

When the first European fur traders began exploring this Basin in the mid eighteenth century, they encountered extensive grasslands with a scattering of wetlands and aspen bluffs. The Touchwood Hills in the western portion of the Basin were vegetated by large tracts of aspen. The Boreal area in the north had mixed-wood forests of spruce, aspen and birch. The Basin was first used for fur production in about 1790 with the establishment of trading forts.

European settlement and the subsequent conversion of grasslands to cultivation began around 1880 and accelerated through the early twentieth century. Historical accounts speak of very few trees in the Basin at the time of settlement. The aspen bluffs presently located throughout areas of intense agriculture are said to be the result of the absence of the earlier, wide-scale prairie fires.

Land use changes took place in the Basin as a result of the conversion to agriculture. This transition was in part the result of deliberate immigration and settlement policies, wetland policies, and agricultural programs and policies.

While economic activity and land use are dominated by mixed grain and wheat farms, pasture and hay lands are also common. Small livestock operations can be found throughout the Study area and the development of feedlots and intensive livestock operations close to the larger communities is becoming more common. The beef cattle industry has dominated the livestock sector. However, there is increased interest in intensive hog production.

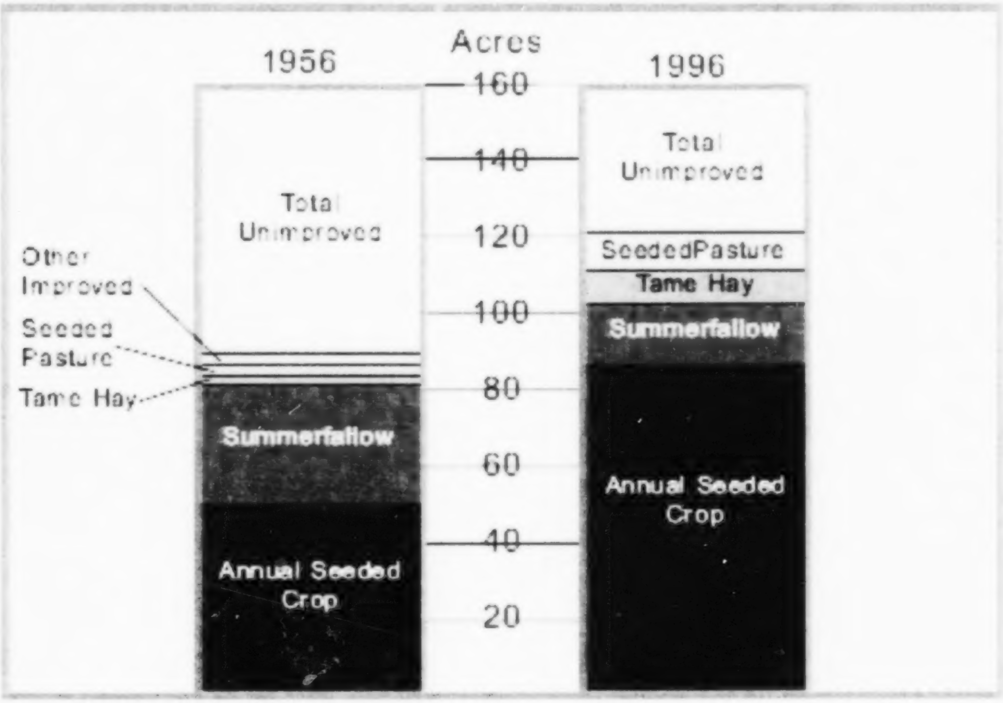
An indication of the changes in land use is provided in ***Figure 8: Land Use Comparison by Quarter Section***, which compares the land use of an average quarter section in 1956 with 1996. ***Table 1*** provides a summary of the types of land cover found in the Basin.

Table 1: Land Cover

Land Cover	Per cent
Cropland	58
Grass	17
Trees	14
Shrub	5
Wetland	5
Large Lakes	1

Data Source: 1990s Western Grains Transition Payment Program

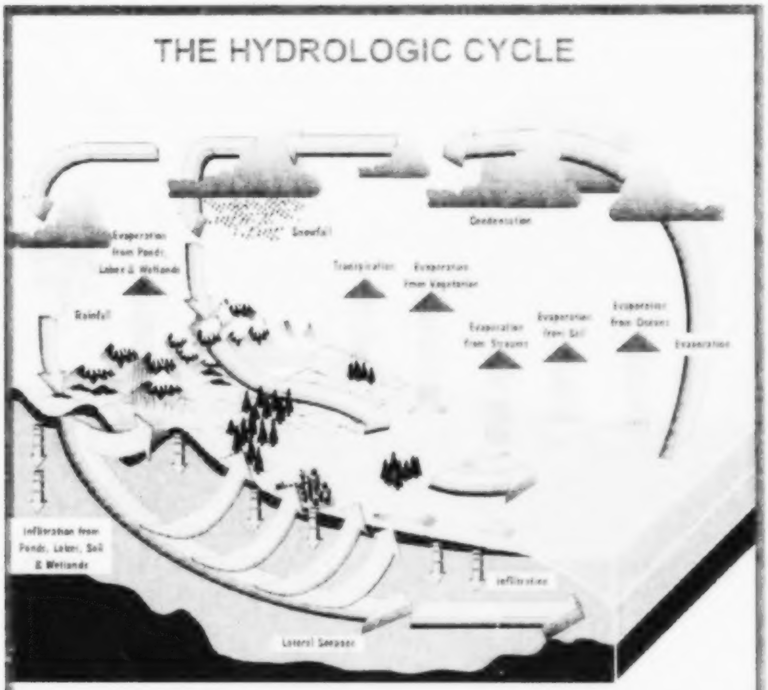
Figure 8: Land Use Comparison by Quarter Section, 1956 versus 1996



2.4 Climate

The climate of the Basin can be thought of in the context of the global hydrologic cycle. In any analysis of the hydrologic cycle the main theme is the concept that water is being constantly circulated within a closed system (the earth). In reviewing ***Figure 9: The Hydrologic Cycle***, it is apparent that there are several paths that water can follow. The sun provides the energy to drive the cycle of water evaporating and circulating to the atmosphere where it condenses and then falls as rain or snow. The water then returns to the ocean via surface runoff in streams and rivers, and by groundwater seepage. There are a number of internal circuits that can occur and these may operate at different speeds (e.g. the relatively short time for evaporation from a lake to condensation and return rainfall compared to the much longer time for water to travel via a groundwater route, which can extend for several hundred thousand years).

Figure 9: The Hydrologic Cycle


THE HYDROLOGIC CYCLE
Condensation
Snowfall
Evaporation from Ponds, Lakes & Wetlands
Transpiration
Evaporation from Vegetation
Rainfall
Evaporation from Streams
Evaporation from Soil
Evaporation from Oceans
Evaporation
Infiltration from Ponds, Lakes, Soil & Wetlands
Infiltration
Lateral Seepage

Powered by solar energy, water circulates endlessly from the atmosphere to land and back to the atmosphere. Water evaporates from oceans, circulates with the atmosphere, condenses within clouds and is eventually precipitated as rain or snow. Most of the water that falls on the land returns to the oceans by surface run-off and groundwater seepage. Flow on its return to the ocean maybe temporarily stored in wetlands, lakes and glaciers. Within this major system are many smaller cycles such as evaporation and transpiration from plants.

The climate of the area is continental sub-humid. It is characterized by long, cold winters and short, warm summers. The mean annual temperature in the Basin is about 1°C. The normal frost-free season extends from 90 to 110 days (102 at Kamsack). The annual growing degree days varies from 1,400 near Preeceville to 1,600 near Cote.

The following is a description of the key climatic elements within the hydrologic cycle as applied to the Basin.

Precipitation

Most of the moisture is provided by air masses originating near the Gulf of Mexico. Convection activity in these air masses during the summer months regularly contributes significant rainfall amounts. The annual precipitation in the Basin averages about 450 mm although it is slightly less in the west and increases to the east. On average about 74 percent of the precipitation occurs as rainfall and the remaining 26 percent is snowfall ***(see Figure 10: Monthly Precipitation at Yorkton).***

At Yorkton, the average annual precipitation at Yorkton is 440 mm. ***Figure 11: Total Annual Precipitation at Yorkton,*** shows the variation in annual precipitation at Yorkton for the years 1961 to 1996. For the period of 1961- 1996, rainfall amounts for the Basin have varied annually from 140 mm in 1961 to 550 mm in 1981. The lowest amount of snowfall was in 1981-82 with 42 cm, and the maximum snowfall recorded occurred in 1965-66 with 217 cm. These snowfalls are equivalent to 42 mm and 217 mm of water respectively.

Figure 10: Monthly Precipitation at Yorkton

Monthly Precipitation at Yorkton

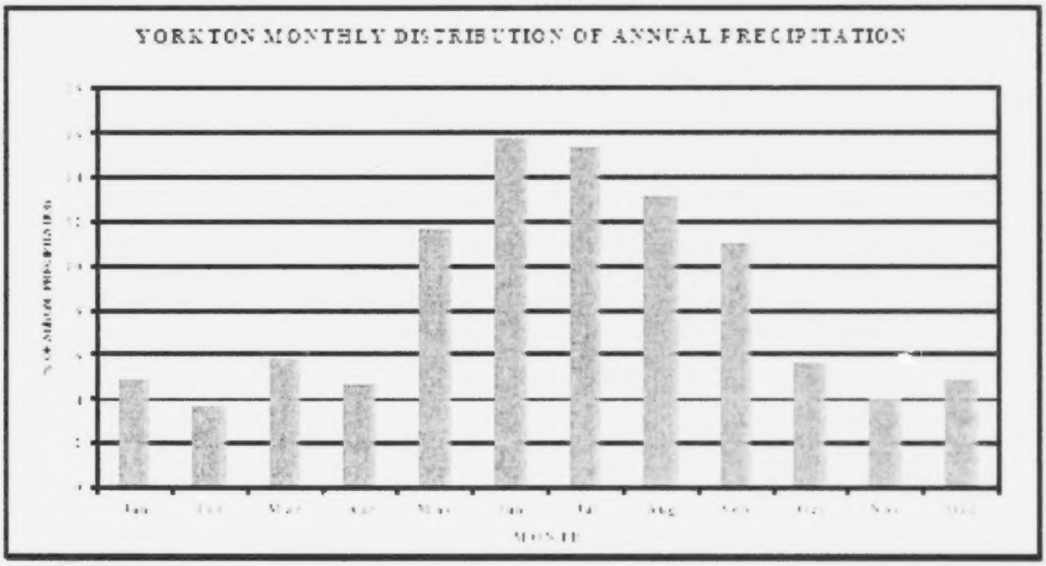
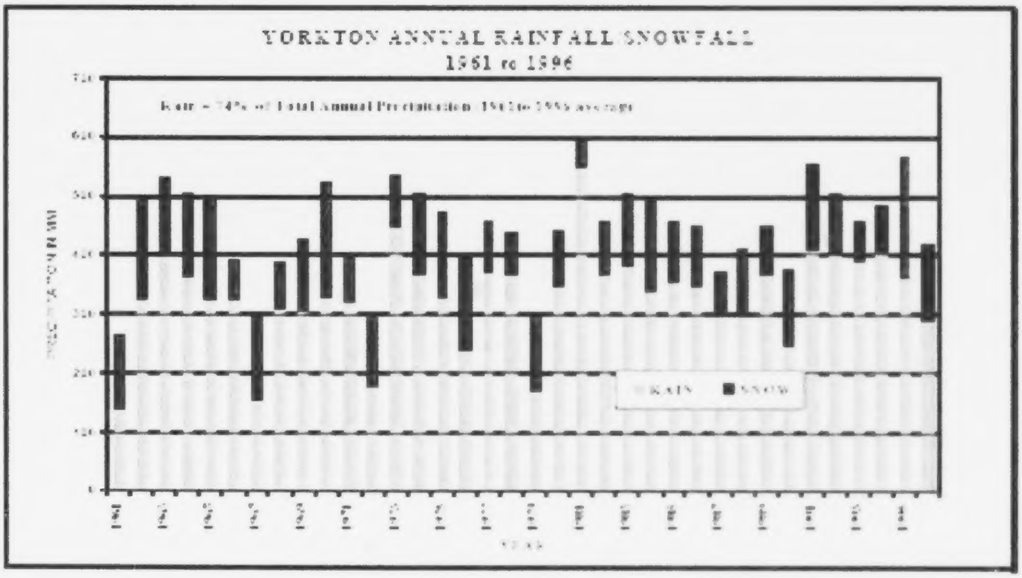


Figure 11: Total Annual Precipitation at Yorkton

Total Annual Precipitation at Yorkton



Evaporation

The mean annual potential evaporation from a water body for the Yorkton area is 850 mm. The value for an extreme dry year is 1090 mm. During a very hot day about 10 mm can evaporate. The term 'Net Evaporation' is used by hydrologists to describe the net effect of evaporation from the surface of a water body minus precipitation onto the water body. For the Yorkton area, the 850 mm average annual evaporation minus 440 mm average annual precipitation yields 410 mm average annual net evaporation.

Evaporation during the winter, a process known as sublimation, occurs when snow or ice vaporizes; that is, it changes directly from the solid phase to the vapour phase. In the Basin, sublimation typically averages 15 to 20 percent of the annual snowfall.

Transpiration

Most of the water absorbed by the roots of plants is discharged to the atmosphere as vapour through plant leaves. The depth of the roots affects the ability of plants to transpire water to the atmosphere. As neither evaporation nor transpiration can be easily or directly measured, they are usually combined. Evapotranspiration is the term used for the combination of evaporation from the soil surface and transpiration. In the Canadian Prairies, annual evapotranspiration can be as high as 80 to 90 percent of the annual precipitation.

2.5 Demographics

The population of the Assiniboine River Watershed (within Saskatchewan) is approximately 45,500 persons, which is based on the population values listed in the 2005 Municipal Directory (2001 census data). The population for 1994 was estimated to be 48,500 and in 1974 the population exceeded 54,000. The latest rural population numbers (based on on-farm, villages and hamlets) is 15,300. It should be noted that populations in the individual RM's were prorated based on the area percentage of the RM within the Basin. The rural population represents about 34 percent and the urban or community population is 66 percent.

Thirty seven percent of the total population resides in the City of Yorkton. If the population of the City of Yorkton and the surrounding 4 RM's (Orkney, Cana, Wallace and Saltcoats), including the towns and villages, is summed it comprises 50 percent of the total watershed population.

3. Economic Activities

There are approximately 23 rural municipalities, in whole or in part, located in the watershed, which is well serviced by road and rail. Yorkton is the regional centre for trade. The trading area population of Yorkton (150 km radius) is 111,193. Much of this is based on agricultural trade. The city has a well developed infrastructure including service by rail and highway. It has hospitals, schools, regional colleges for training and other services essential to sustain population growth. There are around 10 smaller but important trading centres in the watershed with a good agriculture and urban business base.

3.1 Agriculture

While economic activity and land use are dominated by mixed grain and wheat farms, pasture and hay lands are also common. Small livestock operations can be found throughout the Study area and the development of feedlots and intensive livestock operations close to the larger communities is becoming more common. The beef cattle industry has dominated the livestock sector. However, there is increased interest in intensive hog production.

Agricultural Land Use

Located in an area of diverse soil types, ranging from black soil to dark gray and grey soil, the watershed is situated in the aspen parkland region. Blessed with adequate precipitation, the area was one of the few in western Canada to miss the droughts of '88-'89 and '01-'02. Farming operations are diverse including crop production, registered seed production with on-farm processing, fruit production (strawberries, saskatoons, and sea buckthorn), maple syrup production and potato production. There are also organic producer groups in the area (in excess of 100) and many more producer groups working toward organic certification. With some areas of the watershed having marginal cropland and good moisture, agro-forestry has become a viable option.

On an RM basis, ***Figure 12: 2001 Land in Crops*** shows that the average number of cropped acres per RM is 105,000 – 140,000 acres. There are a few pockets with a higher proportion of land committed to crop production but the larger proportion of the land appears to be used for pasture. The use of summerfallow remains considerable in the watershed although this practice has significantly decreased over the last decade (***Figure 13: 2001 Land in Summerfallow***).

Figure 12: 2001 Land in Crops

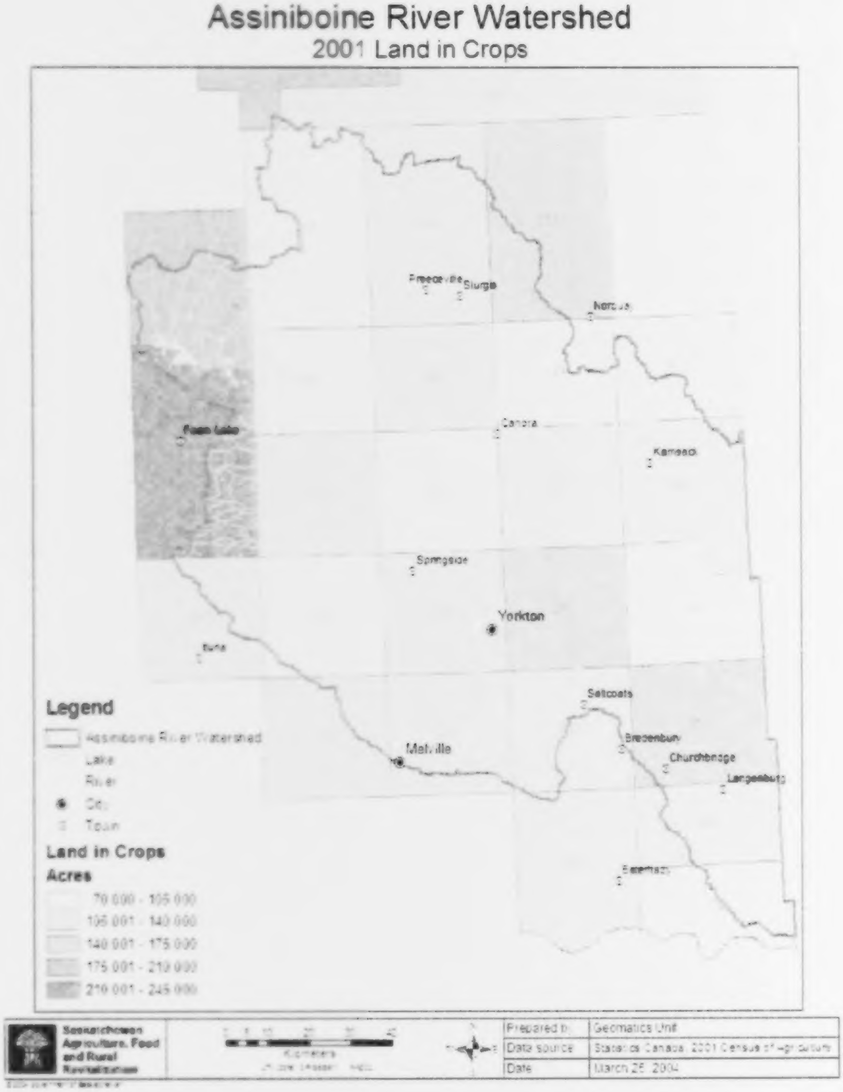

Assiniboine River Watershed
2001 Land in Crops
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Land in Crops
Acres
70 000 - 105 000
105 001 - 140 000
140 001 - 175 000
175 001 - 210 000
210 001 - 245 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Statistics Canada: 2001 Census of Agriculture
Date
March 25, 2004

Figure 12: 2001 Land in Crops

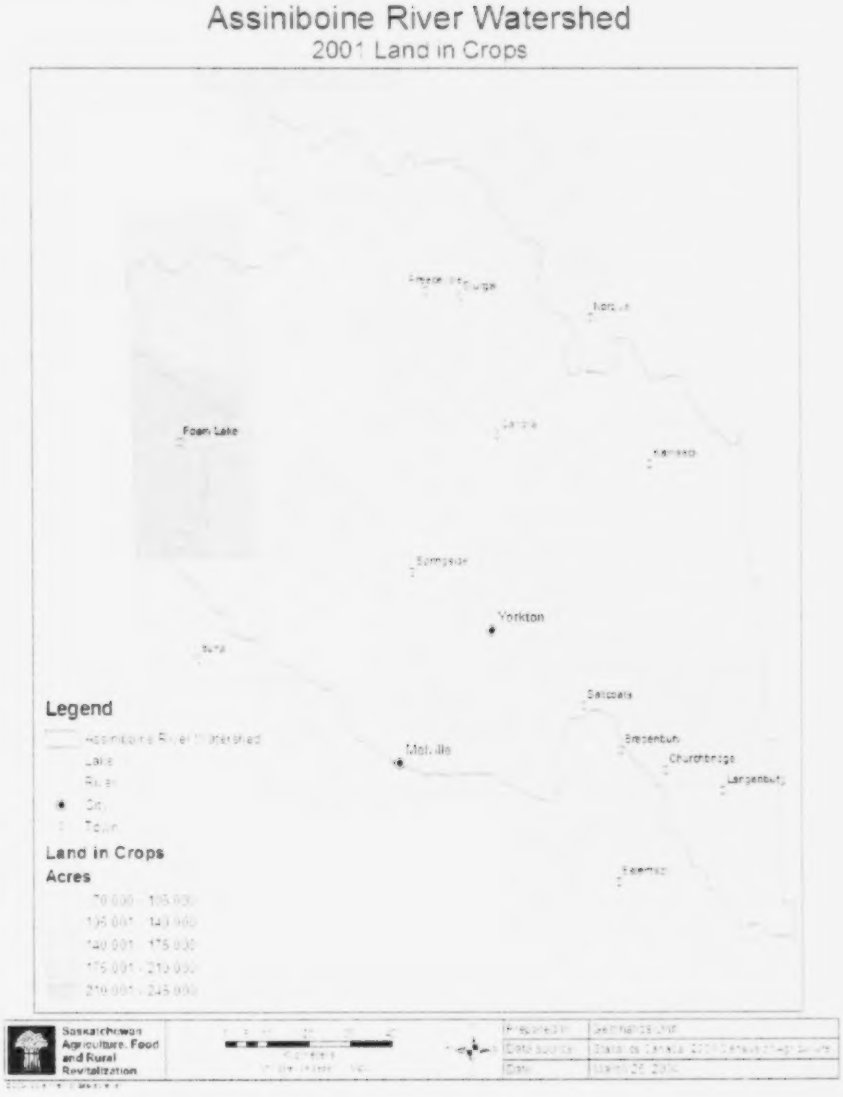
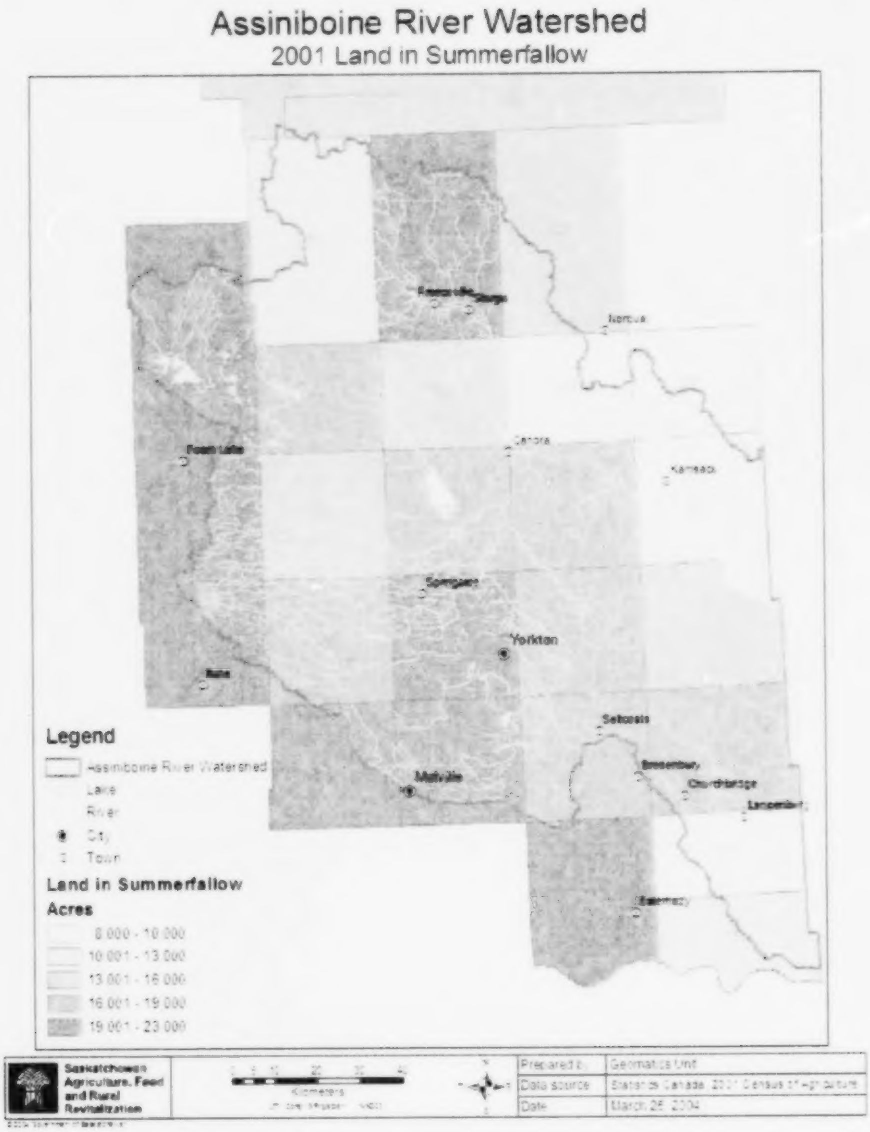

Assiniboine River Watershed
2001 Land in Crops
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Bredenbury
Melville
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Land in Crops
Acres
70 000 - 105 000
105 001 - 140 000
140 001 - 175 000
175 001 - 210 000
210 001 - 245 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by:
Data source:
Statistics Canada 2001 Census of Agriculture
Date:

Figure 13: 2001 Land in Summerfallow

Assiniboine River Watershed
2001 Land in Summerfallow
Preeceville
Sturgis
Foam Lake
Springside
Yorkton
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Land in Summerfallow
Acres
Saskatchewan Agriculture, Food and Rural Revitalization

Crop production in the region can be defined as conventional, with the majority of crops produced in the watershed being exported for processing. The opportunities for growth in this sector appear to lie with the organic sector and the seed processing industry. For the seed processing industry it is perhaps reasonable, given the crop production numbers, to consider the development of additional seed processing facilities in the area. Along with the increase in interest and production, there is a need for increased technical information.

Figure 13: 2001 Land in Summerfallow


Assiniboine River Watershed
2001 Land in Summerfallow
Preeceville
Sturgis
Norquay
Canora
Kamsack
Foam Lake
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Land in Summerfallow
Acres
8 000 - 10 000
10 001 - 13 000
13 001 - 16 000
16 001 - 19 000
19 001 - 23 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Statistics Canada, 2001 Census of Agriculture
Date
March 26, 2004

Crop production in the region can be defined as conventional, with the majority of crops produced in the watershed being exported for processing. The opportunities for growth in this sector appear to lie with the organic sector and the seed processing industry. For the seed processing industry it is perhaps reasonable, given the crop production numbers, to consider the development of additional seed processing facilities in the area. Along with the increase in interest and production, there is a need for increased technical information.

An analysis of Agricultural Land Cover was conducted for the Upper Assiniboine River as part of the UARB Study. Changes in the land use and practices on a watershed can have impacts on the hydrology and the water quality of the Basin.

Table 2: Land Use Changes

Land Use	**1956**	**1996**
Average Farm Size	163.5 ha	345.6 ha
Annual Seeded Crop	52.5 ha	186.4 ha
Summer Fallow	30.8 ha	35.8 ha
Tame Hay	2.8 ha	22.3 ha
Seeded Pasture	3.0 ha	19.8 ha
Total Improved	91.6 ha	264.3 ha
Total Unimproved	71.9 ha	81.2 ha
Total Number Of Farms	13,873	6,578
Approximate Rural Population	57,600	23,200
Approximate Urban Population **	33,300	43,000

** includes Cities, Towns & Hamlets

Figure 14: 1956 Agricultural Stats

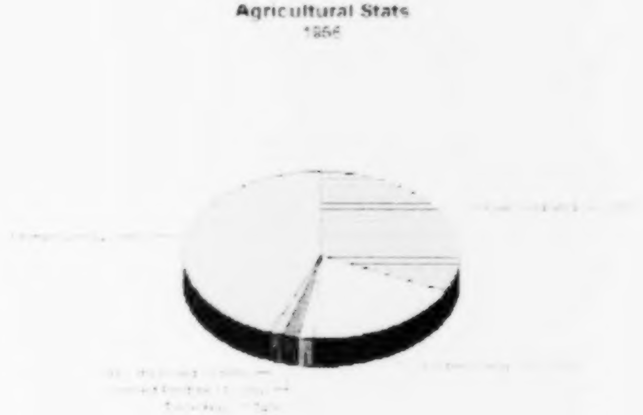


Figure 15: 1996 Agricultural Stats

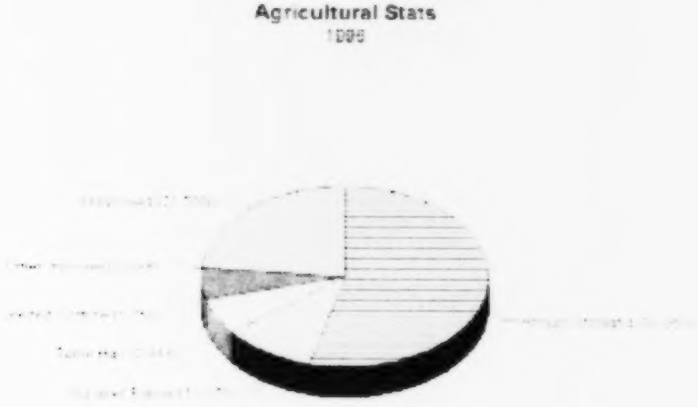
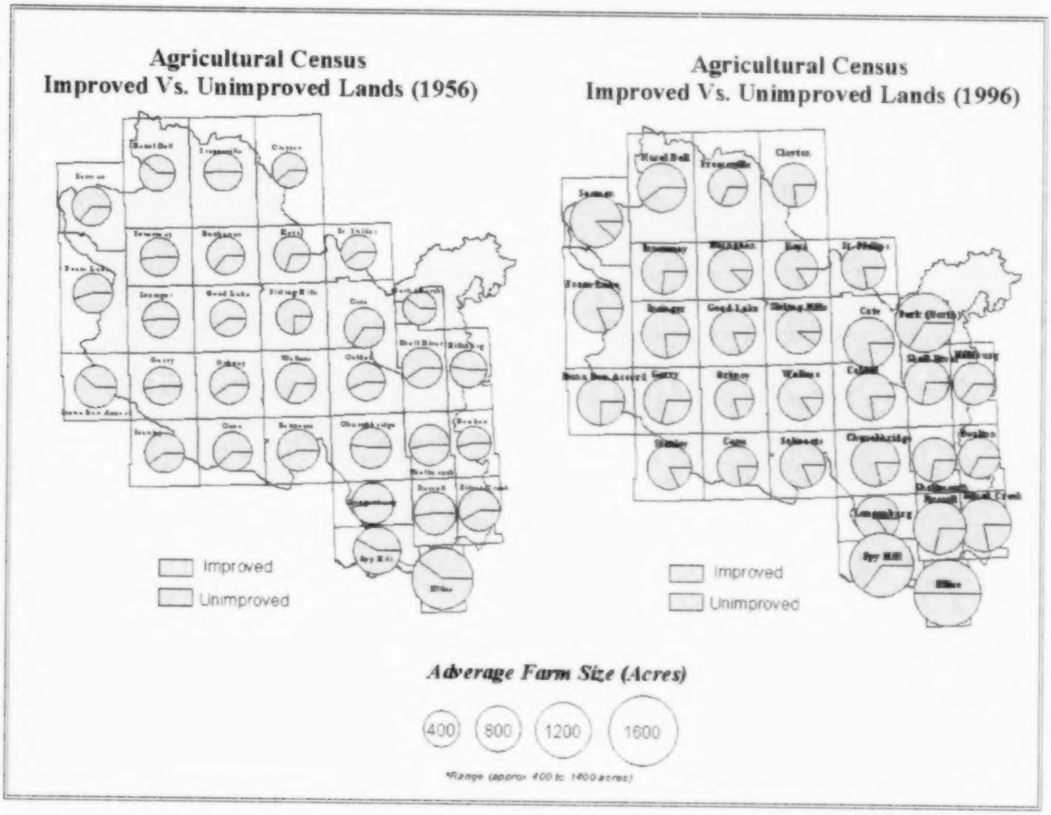


Figure 16: Improved Vs. Unimproved Lands


Agricultural Census Improved Vs. Unimproved Lands (1956)

Agricultural Census Improved Vs. Unimproved Lands (1996)

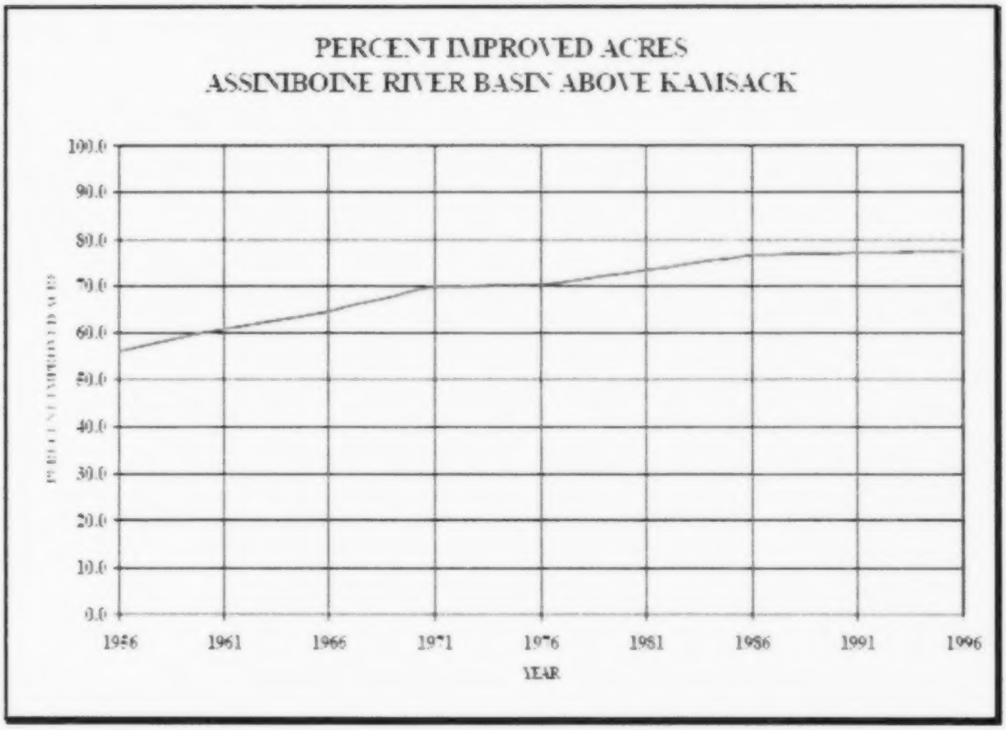
Improved
Unimproved
Improved
Unimproved
Adverage Farm Size (Acres)
400
800
1200
1600
*Range (approx. 400 to 1400 acres)

A review of Figures 14, 15, and 16 indicates dramatic changes in the Assiniboine River Watershed landscape. The average farm shows a nearly 50 percent reduction in 'unimproved' area. This represents lands which are not broken, cleared or drained, basically natural parklands. There has been an accompanying increase in improved lands, that is, annual seeded crop, of 67 percent from 1956 to 1996. The average farm size has increased, while the rural population is falling while the urban numbers are more or less steady.

Figure 17: Percent Improved Acres, is another example of the change that is occurring.

Figure 17: Percent Improved Acres

Percent Improved Area Upper Assiniboine River Basin above Kamsack.



Manure Management

Manure management differs by species, and this affects potential watershed impact. ***Table 3: Typical Manure Management by Species*** shows an overview of typical manure management based on species.

Table 3: Typical Manure Management Based on Species

	Animal Housing	Manure Type	Application Frequency	Application method	Manure Storage
Poultry	Barn	Solid	6 x / year	Surface	In barn
Hogs	Barn	Liquid	2 x / year	Injection	earthen manure storage (EMS)
Dairy	Barn / pasture	Liquid	2 x / year	Surface	EMS / tank
Beef	Pens / pasture	Solid	2 x / year	Surface	Holding pond

When animals are housed indoors, rainfall is prevented from reaching manure and potentially moving contaminants. When animals are confined outdoors, holding ponds are often constructed to prevent precipitation runoff from reaching watercourses. Injected liquid manure has little opportunity for movement because it is placed below the ground surface. Nitrogen in solid manure is organically bound and takes several years to decompose to water-soluble nitrogen.

Manure injection is an effective way to apply manure to farmland. Saskatchewan researchers were instrumental in developing this technology with assistance from the Agricultural Development Fund. With the exception of some small producers, hog operations use manure injection. Application rates are agronomically balanced to meet expected crop requirements. This limits nutrient movement. The moisture on land following liquid manure injection is approximately equivalent to a half an inch of rainfall.

Saskatchewan Agriculture, Food and Rural Revitalization (SAFRR) established the Spirit Creek Watershed Monitoring Committee in the fall of 2000. The committee monitors the potential environmental impact of a 5,000 sow hog operation on the soil, air and water. All wells and dugouts were sampled within a three mile radius of each barn before the facilities were constructed. Numerous surface samples are collected from watercourses during spring runoff. To date the committee has not measured any degradation of water resources or soil condition within the Spirit Creek Watershed.

Livestock Production

Regulations

The Agricultural Operations Act is administered by the Agricultural Operations section of Saskatchewan Agriculture, Food and Rural Revitalization (SAFRR). The Agricultural Operations program includes:

- Approval of manure storage, manure management, and mortality management plans
- Special conditions of approval for increased water protection
- Re-inspection of approved operations
- Investigation of alleged pollution from intensive livestock operations
- Site characterization for determining environmentally secure sites

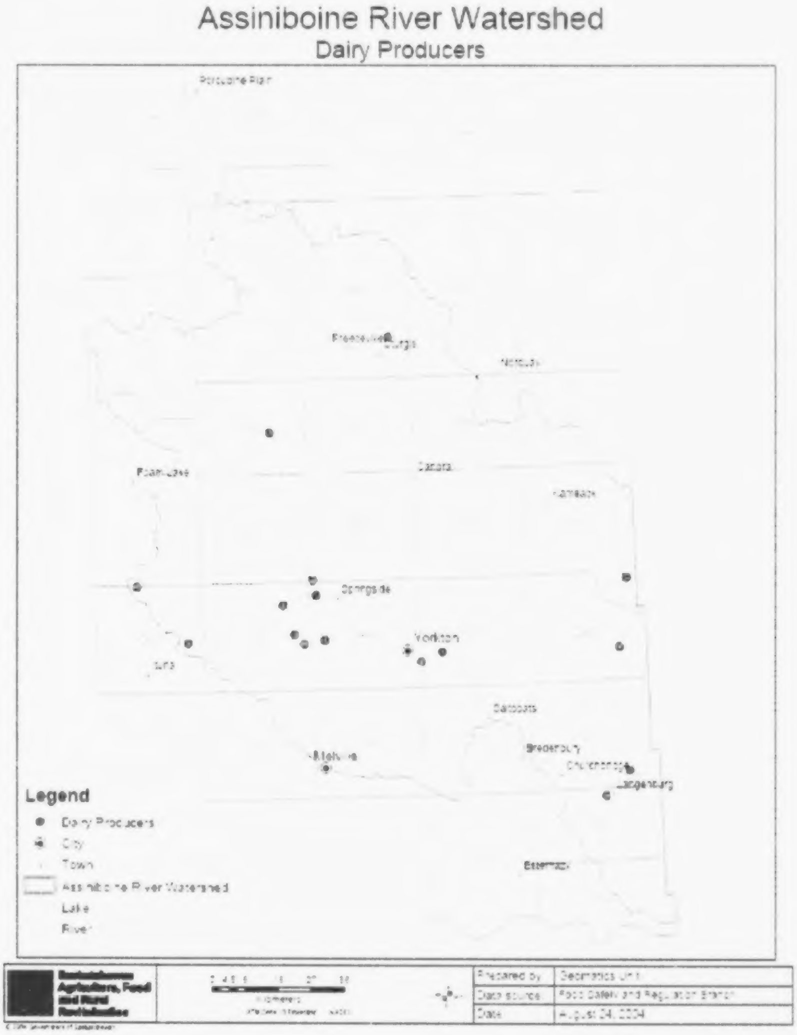
Agricultural Operations is developing site characterization guidelines to assist livestock developers in selecting suitable sites for earthen manure storage. Much of Saskatchewan is underlain by glacial till which is an effective material to securely contain manure. The guidelines will help identify locations with suitable material and sufficient separation from water sources to ensure protection of groundwater. The guidelines are based on a solute transport model developed by Dr. Lee Barbour of the University of Saskatchewan.

The expanding livestock industry is regulated by *The Agricultural Operations Act*. The act requires designated livestock operations, to operate according to approved manure storage and manure management plans for water protection.

Dairy

There are a number of dairies in the watershed (see ***Figure 18: Assiniboine Dairy Producers***). The average dairy herd (on milk recording systems) is about 109 head, as opposed to an average herd size of 50 head 10 years ago. The number of dairies in the watershed has decreased significantly over the past decade.

Figure 18: Assiniboine Dairy Producers


Assiniboine River Watershed
Dairy Producers
Porcupine Plain
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Dairy Producers
City
Town
Assiniboine River Watershed
Lake
River
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Food Safety and Regulation Branch
Date
August 24, 2004

Beef: Cow-Calf

The Assiniboine River Watershed is well suited for expansion of the cow-calf sector. Cattle operations, ***Figure 19: 2001 Total Cattle and Calves***, vary in size throughout the watershed. About 1/3 of the RMs average 6,000 – 9,000 head, 1/3 of the RMs average 9,000 – 12,000 head and a handful of RMs (211, 244 & 334) average 15,000 – 18,000 head. According to SAFRR district reports, current cow-calf numbers for the watershed would be approximately 100,000 head. With the elimination of the Crow benefit, this area has some of the highest freight rates for shipping grain. This has resulted in land prices remaining low when compared to comparable land in other areas. Over the past five years a number of new operators from Alberta have moved into the area, bringing their livestock with them. Interest expressed by established and new producers in expanding their herd would indicate an average increase of 15 percent over the next several years. Business options of cow-calf cooperatives or partnerships have been considered. This may prove beneficial to the feedlot industry as it expands by providing a more standard calf to meet market demand.

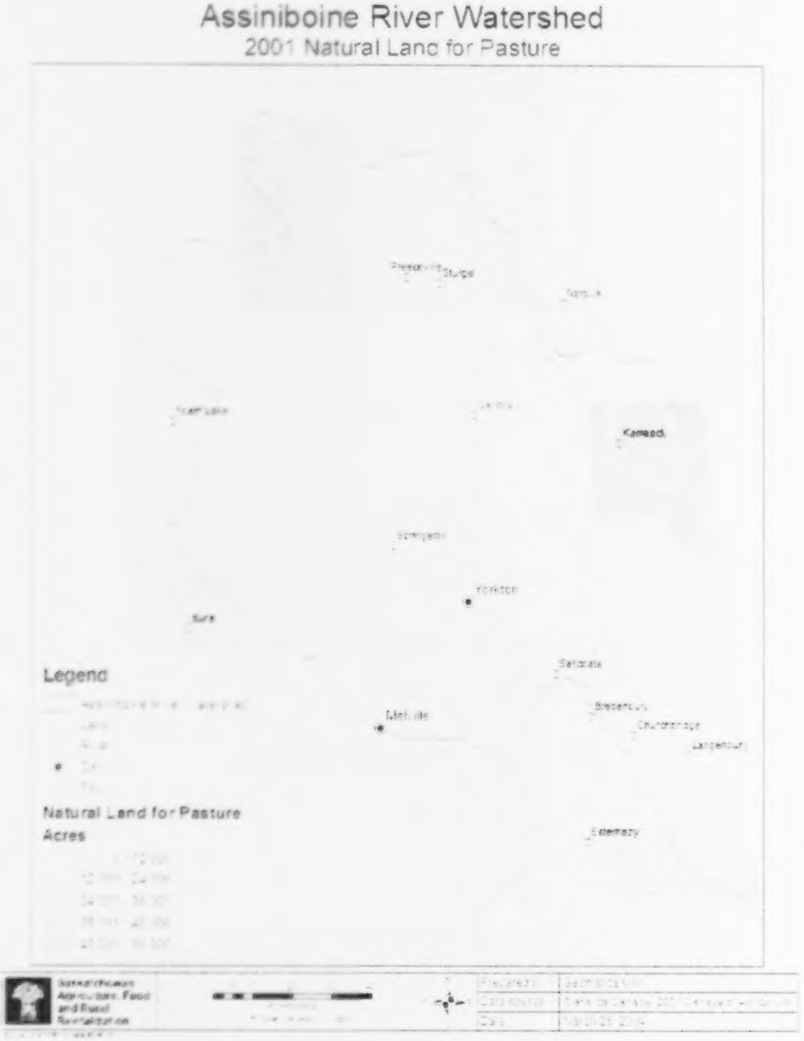
Increases in forage production to support an increased cow-calf herd have been occurring. The watershed is naturally well suited to extensive grazing.

Figure 20: 2001 Natural Land for Pasture and ***Figure 21: 2001 Tame or Seeded Pasture*** depict the extent and distribution by RM of pasture lands in the Assiniboine Basin.

Figure 19: 2001 Total Cattle and Calves

Assiniboine River Watershed
2001 Total Cattle and Calves
Yorkton
Legend
Town
Total Cattle and Calves
Number of Head
Saskatchewan Agriculture, Food and Rural Revitalization

Figure 20: 2001 Native Land for Pasture



Assiniboine River Watershed

2001 Natural Land for Pasture

Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Natural Land for Pasture
Acres
Saskatchewan Agriculture, Food and Rural Revitalization

Figure 19: 2001 Total Cattle and Calves

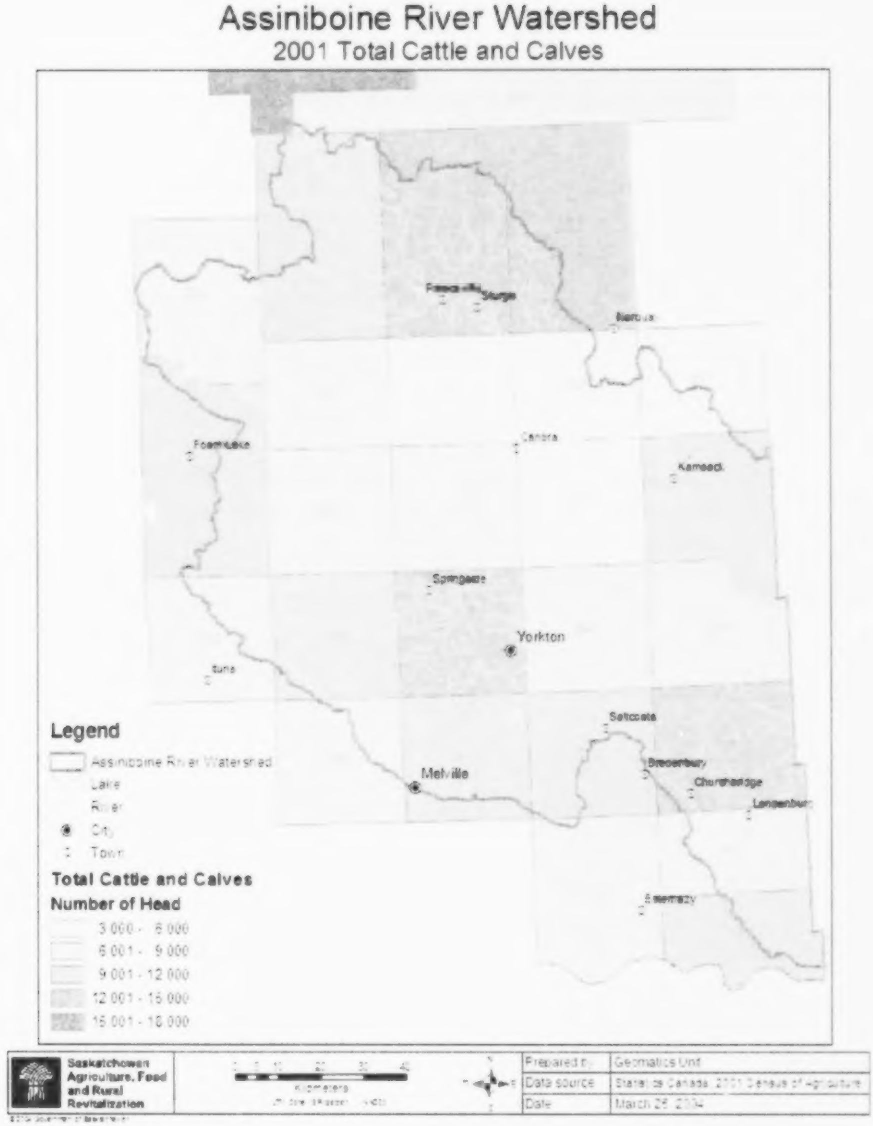

Assiniboine River Watershed
2001 Total Cattle and Calves
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Total Cattle and Calves
Number of Head
3 000 - 6 000
6 001 - 9 000
9 001 - 12 000
12 001 - 15 000
15 001 - 18 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Statistics Canada, 2001 Census of Agriculture
Date
March 25, 2004

Figure 20: 2001 Native Land for Pasture

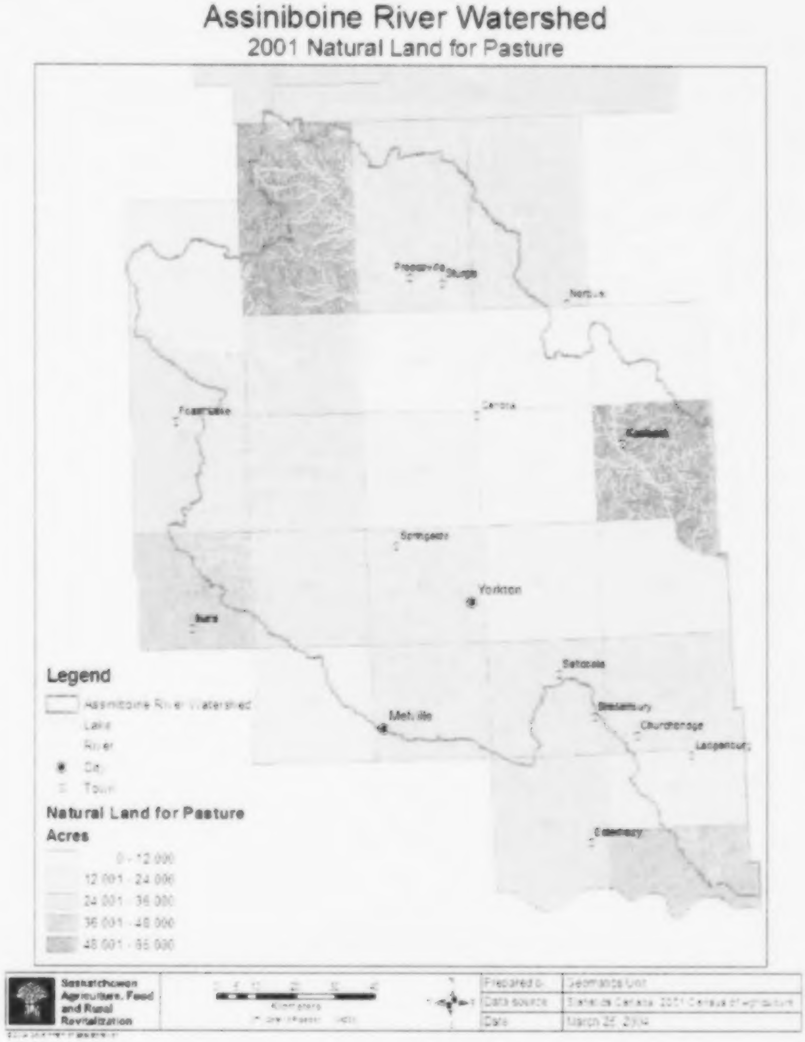
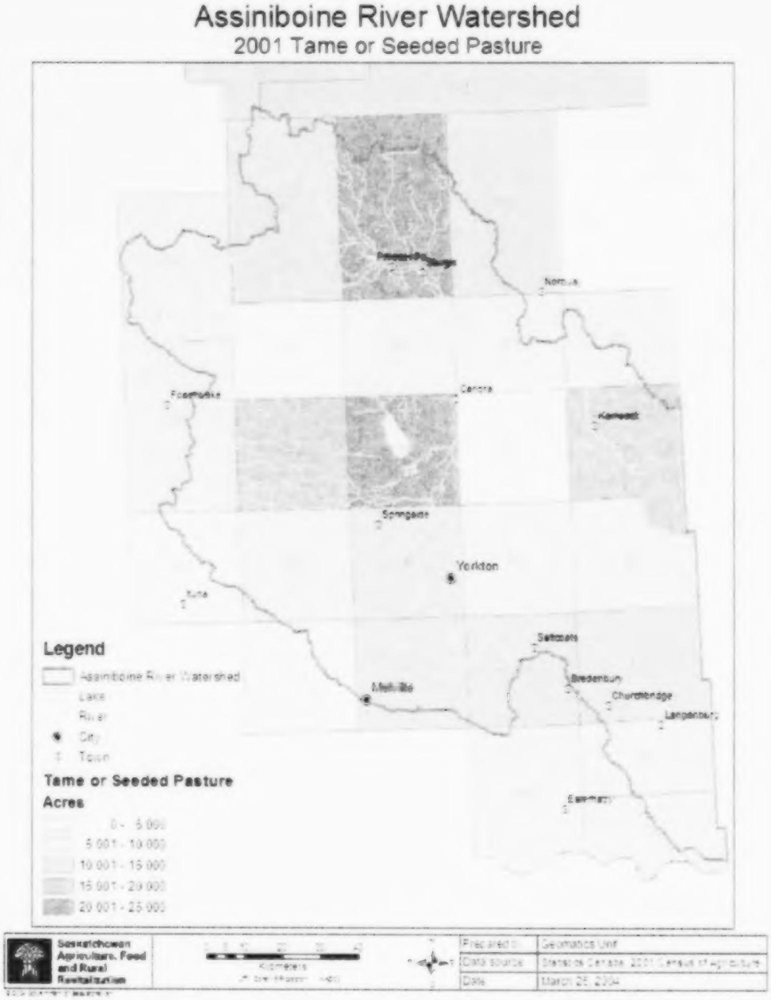

Assiniboine River Watershed
2001 Natural Land for Pasture
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Natural Land for Pasture
Acres
0 - 12 000
12 001 - 24 000
24 001 - 36 000
36 001 - 48 000
48 001 - 65 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Statistics Canada, 2001 Census of Agriculture
Date
March 25, 2004

Figure 21: 2001 Tame or Seeded Pasture

Assiniboine River Watershed
2001 Tame or Seeded Pasture
Yorkton
Melville
Legend
Tame or Seeded Pasture
Acres
Saskatchewan
Agriculture, Food
and Rural
Revitalization

Figure 21: 2001 Tame or Seeded Pasture

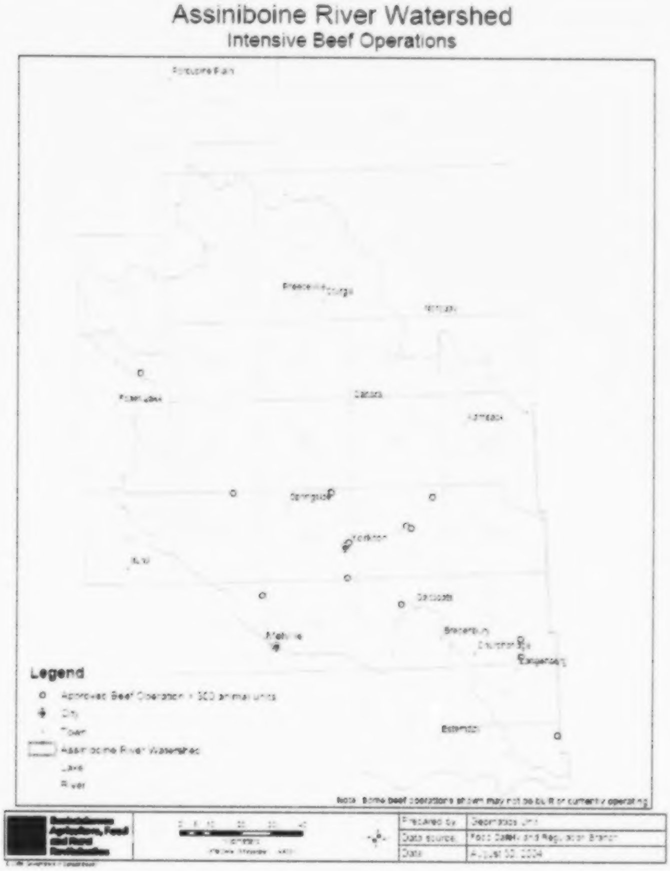

Assiniboine River Watershed
2001 Tame or Seeded Pasture
Norquay
Canora
Foam Lake
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Assiniboine River Watershed
Lake
River
City
Town
Tame or Seeded Pasture
Acres
0 - 5 000
5 001 - 10 000
10 001 - 15 000
15 001 - 20 000
20 001 - 25 000
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Geomatics Unit
Data source
Statistics Canada, 2001 Census of Agriculture
Date
March 25, 2004

Beef: Feedlots

The majority of calves produced in the watershed are moved out of the area for finishing. In addition, a large amount of feed barley is shipped out of the area. There are a few small feedlots (<500 head) and several larger scale facilities. ***Figure 22: Intensive Beef Operations*** shows cattle operations (over 300 animal units) that have received approval under *The Agricultural Operations Act*. It should be noted that some of these may no longer be operating. Communities have initiated discussion for new feedlot proposals but have not actively pursued the idea since the BSE crisis of May 2004.

Identification of reliable water sources and consistent feed supplies are critical to increasing feedlot capacities in the watershed.

Figure 22: Intensive Beef Operations


Assiniboine River Watershed
Intensive Beef Operations
Melville
Legend
Approved Beef Operation > 300 animal units
City
Town
Assiniboine River Watershed
Lake
River
Note: Some beef operations shown may not be built or currently operating
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometers
Prepared by
Data source
Food Safety and Regulation Branch
Date
August 30, 2004

Poultry

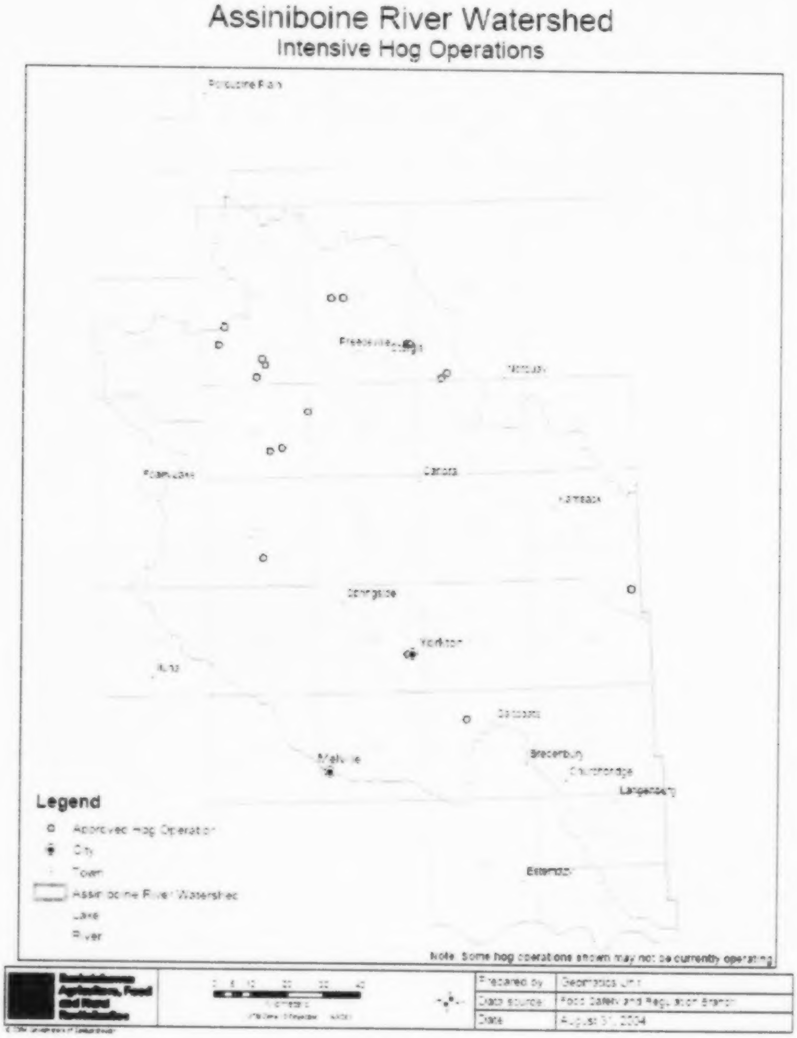
The watershed has a number of broiler chicken producers and approximately half of the turkey production in Saskatchewan. Three new broiler operations have moved into the area over the last several years. The area provides good access to the only poultry processor in Saskatchewan at Wynyard.

Hogs

Hog production has traditionally been a small component of the livestock industry along the eastern side of the province. A 2,400 sow farrow-to-finish operation and a 5,000 sow farrow-to-finish operation have been developed in the watershed within the last five years. The geographic location of the watershed, with its access to abundant feed, provides opportunities for increasing hog numbers. Several communities continue to explore the option of establishing a large hog project in their area, and it is likely that these opportunities will continue to be pursued. ***Figure 23: Intensive Hog Operations*** shows the distribution of hog operations in the Basin.

Some established meat processors in the watershed have been discussing the possibility of increasing capacity and this may also provide an incentive for increased hog production.

Figure 23: Intensive Hog Operations


Assiniboine River Watershed
Intensive Hog Operations
Porcupine Plain
Preeceville
Sturgis
Norquay
Foam Lake
Canora
Kamsack
Springside
Yorkton
Ituna
Saltcoats
Melville
Bredenbury
Churchbridge
Langenburg
Esterhazy
Legend
Approved Hog Operation
City
Town
Assiniboine River Watershed
Lake
River
Note: Some hog operations shown may not be currently operating
Saskatchewan Agriculture, Food and Rural Revitalization
Kilometres
Prepared by
Geomatics Unit
Data source
Food Safety and Regulation Branch
Date
August 31, 2004

3.2 Tourism and Recreation

Recreation is also an important part of the economy. Relief associated with rivers and lakes typically contains groves of aspen, oak and maple, which enhance recreational opportunities. The Assiniboine River provides an excellent canoeing and fishing environment. Provincial and regional parks are located throughout the Basin.

There are several golf courses located in the watershed. In the winter, there are hundreds of miles of groomed snowmobile trails.

3.3 Industry

Industrial activity in the Basin is generally related to the larger urban centres or in the potash and petroleum sectors. Meat packing plants, dairies, concrete manufacturing, bakeries, feed mills and publishing facilities are found in the urban communities.

The watershed area has a very strong agricultural services sector and is home to a very strong agricultural manufacturing base—Morris Industries, Leon Mfg, Ram Industries, Bridgeview Mfg and Castleton Mfg are a few of the local manufacturers, all of whom provide manufacturing and problem solving skills for manufacturing and metal fabrication.

The potash mine at Rocanville, situated immediately south of the southern extent of the Basin, is an important regional employer. The potash beds that underlay much of the region and the brick clay deposits located north of Yorkton comprise the area's mineral resources. As well, Melville forms the hub of the regional petroleum distribution network, with natural gas and liquid petroleum gas storage caverns located adjacent to the community.

There have been recent oil and gas exploration activities ongoing in the north east of the Basin near Kamsack.

4. Water Resources

4.1 Surface Water Resources

Surface runoff is the water that is transported along the surface of the earth, as opposed to within the earth, and reaches a stream or water body soon after the occurrence of the rainfall or snowmelt event. In the Canadian Prairies, surface runoff is usually the residual after evapotranspiration and infiltration losses have occurred.

The study area surface water supply is dominated by two river systems, the Assiniboine River and its major tributary, the Whitesand River. The Assiniboine River extends for a distance of about 1,290 km, of which 350 km lies within Saskatchewan. The origin of the river can be traced to a marsh area about 30 km north of Lintlaw in NW 36-38-9-W2.

The Whitesand River is the largest tributary of the Assiniboine in Saskatchewan. It originates about 20 km north east of Foam Lake. The distance to the confluence with the Assiniboine River near Kamsack is about 163 km.

HYDROMETRIC INFORMATION

Typical of most prairie streams, the Assiniboine River displays peak flows during the spring, originating from snowmelt. The flow rapidly decreases to a diminishing base flow derived from groundwater which persists throughout the summer months as shown in ***Figure 24: Assiniboine River Average Annual Monthly Flow***. The spring melt characteristic is even more pronounced for smaller subwatersheds in the

Assiniboine Basin as depicted in ***Figure 25: Spirit Creek Average Annual Monthly Flow***.

Figure 24: Assiniboine Average Annual Monthly Flow

Assiniboine River at Kamsack

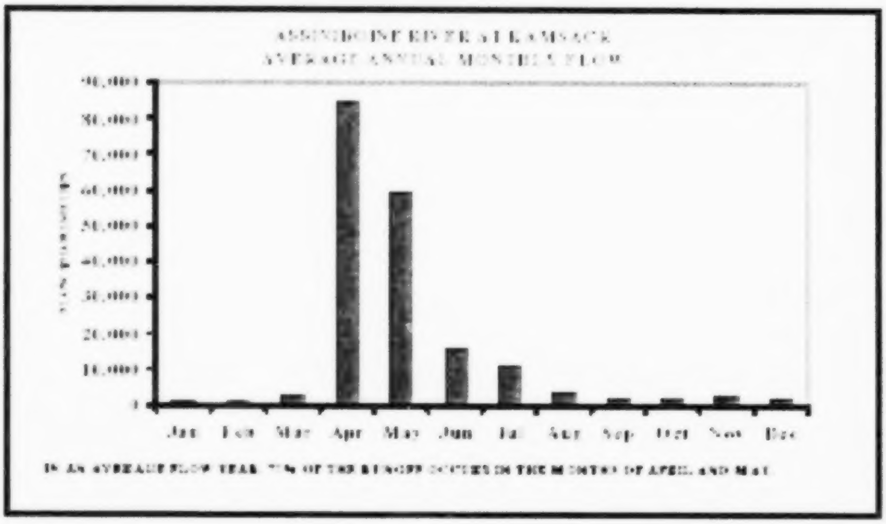
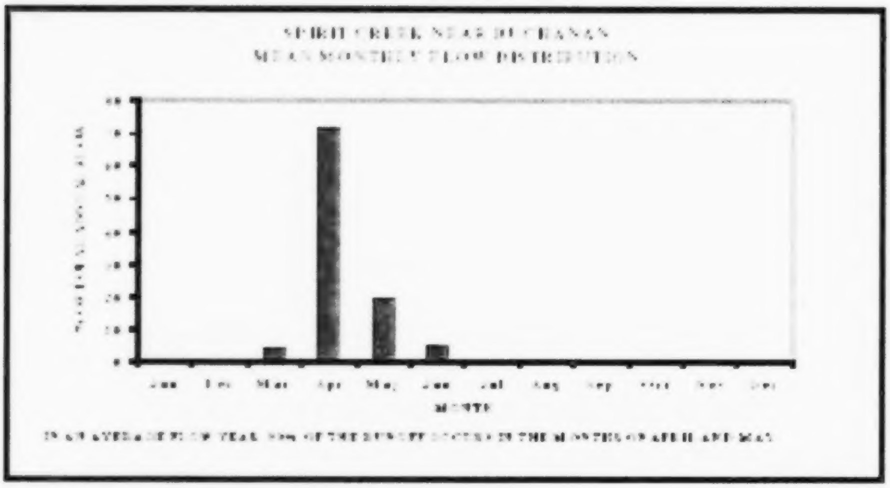


Figure 25: Spirit Creek Average Annual Monthly Flow

Spirit Creek near Buchanan



Streamflow and lake level measurements within the Study area are jointly administered by the Saskatchewan Watershed Authority and Environment Canada. Twenty-two stations have been operated in the Assiniboine River Basin; seventeen remain active. There are three additional stations located downstream of the provincial boundary in Manitoba which are of significance to the study area.

Five of the hydrometric stations are of hydrological importance due to their long period of record and their location; the Assiniboine R near Russell (the 1st station downstream in Manitoba), the Assiniboine R at Kamsack (below the confluence with the Whitesand), the Assiniboine R at Sturgis in the upper portion of the Basin, the Whitesand R near Canora (immediately upstream of the confluence with the Assiniboine) and Yorkton Ck near Ebenezer (upstream of the confluence with the Whitesand).

Table 4: Annual Discharge Values for the Assiniboine River Basin

Hydrometric Stream		**Discharge (dam^3)**	
	Maximum	**Minimum**	**Mean**
Assiniboine near Kamsack	453,000	5,710	167,000
Assiniboine near Russell	1,820,000	60,100	459,000
Whitesand near Canora	232,000	627	58,500
Yorkton Ck near Ebenezer	51,400	94	12,200

Calculations of the basin surface water supply are based on natural flows calculated by the Prairie Provinces Water Board (PPWB). The PPWB is a federal/tri-provincial body established to monitor flow apportionment among the three prairie provinces. They have developed natural flows (flows that would have occurred under natural conditions prior to the intervention of man) for the Assiniboine River at the provincial boundary.

The Basin water supply for the Assiniboine River near the provincial boundary is extremely variable, similar to the above description. For the months of April and May, 63 percent of the mean annual natural flow occurs. Only 3 percent flows during December through March.

The Assiniboine River water supply, from an annual perspective, is also highly variable. Between 1912 and 1993, the annual natural flow ranged from an historical low of 17,000 dam^3 in1989 to a recorded maximum of 1,471,000 dam^3 in 1922. The mean annual natural flow of the Assiniboine River amounts to 265,000 dam^3. The flood of 1995 had flows approaching 900,000 dam^3.

SURFACE WATER QUALITY

The quality of the larger sources of surface water in the Upper Assiniboine River Basin is generally acceptable for most uses. However, smaller water bodies have marginal water quality, a trait common to the prairie region. Poor water quality is often attributable to human activity, although natural conditions such as soil characteristics can play a significant role.

Area soils are often rich in bacteria, nutrients and salts. They can work their way into water supplies over the course of the year, especially during snowmelt or as a result of groundwater contribution to surface supplies. Water quality problems are usually associated with taste and odour problems (another major potential water quality issue is toxin production from cyanobacteria, also aesthetics) linked to algae growth in reservoirs. Nutrient inflows from municipal lagoons, livestock operations and runoff from agricultural lands contribute to this problem.

The resulting water quality depends on the type and volume of the pollutant, original quality of the receiving water, its assimilative capacity, level of mixing, rate of water flows, rate of chemical and biological changes during its flow periods, and other specific use requirements. Major sources of surface water pollutants in the Basin include effluent from sewage treatment facilities and suspended sediments, nutrients and pesticides in runoff from agriculture and livestock operations. Storm water runoff from towns and cities may be another major source of pollution.

Periodic sampling has been conducted in the Basin as part of specific studies on major water bodies including Fishing Lake, Good Spirit Lake, Whitesand River, Assiniboine River, and Lake of the Prairies. Water supplies to and wastewater from towns and cities are also sampled as part of regulated treatment operations.

In addition to these studies, monitoring conducted on the Assiniboine River below Kamsack at the PPWB station near the interprovincial boundary provides the most comprehensive information on the Basin. Water quality data have been collected on a monthly basis since 1974. Data from this site was analyzed for long-term trends over the 17 years. The resulting report, "Water Quality Trends in the Assiniboine River at the Interprovincial Boundary", shows no constituent had any significant long-term increasing water quality trend. Long-term decreasing trends were found for nickel, fecal coliform and alpha BHC. However, variables such as total phosphorus, dissolved oxygen and total manganese exceeded the PPWB water quality objectives, and were identified as a potential concern.

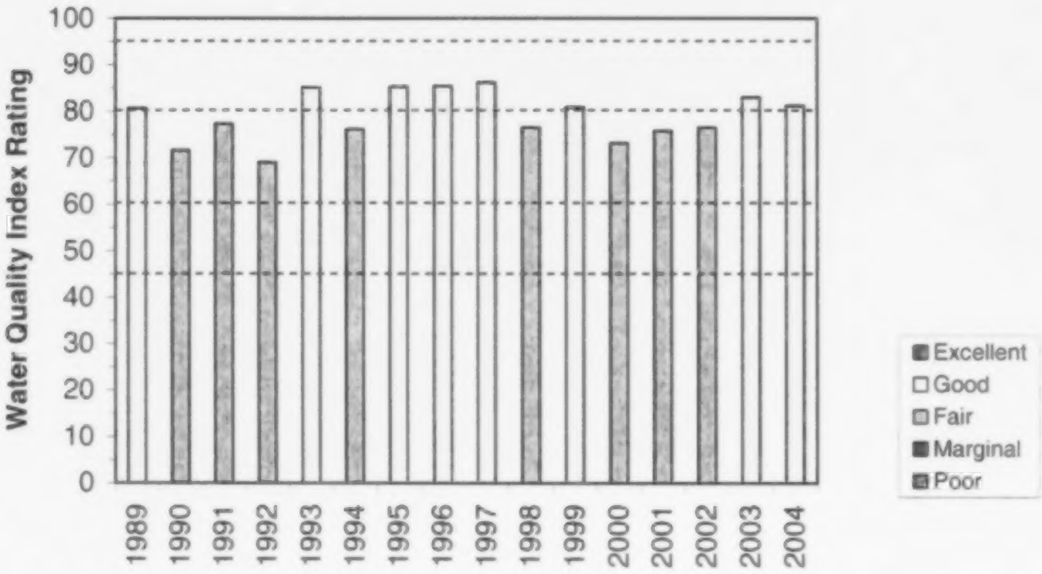
As part of the updating for this background report, existing available water quality data in the provincial database for the Assiniboine River was reviewed and assessed for long term trends in water quality. The complete report with accompanying graphs and tables can be found in ***Appendix C***.

The following is a summary of the report findings:

- The water quality on the Assiniboine River at the PPWB station near Kamsack was evaluated using the Water Quality Index. The results shown in ***Figure 26: Water Quality Index for the Assiniboine River near Kamsack*** indicate that for the years 1989 to 2004, the WQI was found to be consistently fair to good. There was not a great deal of variation in the WQI from year to year or over the review period. The following is an excerpt from the report.

- Total Phosphorous often exceeded its objective (for the Water Quality Index calculations).
- Total Dissolved Solids frequently exceeded its objective and dissolved oxygen occasionally did not meet its objective. There are no increasing or decreasing trends apparent in the water quality parameters over the time period reviewed.

Figure 26: Water Quality Index rating for watershed protection at Kamsack on the Assiniboine River.



Dashed lines correspond to WQI ratings (95-100 = 'Excellent', 80-95 = 'good', 60-80 = 'fair', 45-60 = 'marginal', less than 45 = 'poor'

The following table summarizes the parameters and objectives used to calculate the Water Quality Index rating.

WQI parameters and objective values.

Category	Water Quality Parameter	Non-compliance objective
General		
	pH	< 6.5 or > 8.5
	Dissolved Oxygen (DO)	< 5.0 mg/L
	Chlorophyll *a* (Chl *a*)	> 50 µg/L
Dissolved Solids and Major Ions		
	Total Dissolved Solids (TDS)	> 700 mg/L
	Dissolved Sodium (Na^+)	> 100 mg/L
	Dissolved Chloride (Cl^-)	> 100 mg/L
	Sulphate (SO_4^{2-})	> 500 mg/L
Nutrients		
	Total Phosphorus (TP)	> 0.1 mg/L
	Nitrate/Nitrite (NO_3^-/NO_2^-)	> 1.0 mg/L
	Total Ammonia Nitrogen (NH_3)	pH and temp. dependent¥
Heavy Metals		
	Total Arsenic	> 50 µg/L
	Total Aluminium	> 5 mg/L
	Total Chromium	> 20 µg/L
	Total Mercury	> 0.1 µg/L
Pesticides		
	2,4-D□	> 4 µg/L
	MCPA§	> 25 µg/L
Micro-biological		
	Fecal Coliforms	> 10 00 cfu*/ 100 mL

¥ The objective value for total ammonia nitrogen varies with temperature and pH. When temperature is less than 30°C and pH is less than 9, the objective concentration of un-ionized ammonia is less than 33µg/L.

□ 2,4-Dichlorophenoxyacetic Acid.

§ MCPA, dimethylamine salt.

• Colony forming unit.

EXISTING INFRASTRUCTURE

The Basin contains a limited number of natural lakes, most of which are located in the western portion of the Study area. The largest of these is Good Spirit Lake, which is situated southwest of Canora. Outflow from the lake does not occur every year, and it has been subject to fluctuating levels due to varying rates of inflow and wave-induced buildup of sand at the outlet. An outlet structure was developed in 1988 which now provides some degree of lake level regulation. The Horseshoe Lake complex, a waterfowl enhancement project developed by Ducks Unlimited Canada, is situated immediately south and downstream of Good Spirit Lake.

The lake complex south of Yorkton is also an important feature. The lakes include Upper and Lower Rousay lakes, York Lake, Leech Lake, Crescent Lake and Maddaford Marsh. A series of control structures regulate lake levels and downstream releases. The main objectives of the Yorkton South Project are flood control, stabilization of lake levels to enhance waterfowl production and recreational use, and aquifer recharge. Other important lakes include Fishing Lake and Crystal Lake.

Surface water supply can be affected substantially by drought, particularly in the headwater areas of the Basin. This highly variable and hard-to-predict water supply has led to an emphasis on water storage, since dependable year-round surface water supplies come mainly from large natural or constructed water bodies. Water storage works include dams, dugouts and natural lakes.

The dams and reservoirs in the Basin include the Canora Weir and Theodore Reservoir on the Whitesand River, Melville Dam on Crescent Creek, Kamsack Weir on the Assiniboine River, the Yorkton South Project on Yorkton Creek, and Lake of the Prairies. Lake of the Prairies is formed by the Shellmouth Dam, which is situated on the Assiniboine River 35 km downstream of the interprovincial boundary. The entire reservoir occupies about 8,000 ha, 36 percent of which (2,900 ha) is situated in Saskatchewan.

In addition to the larger dams, the Basin contains numerous small dams providing water storage. Typically, these structures are built to store local runoff for various uses such as municipal and agricultural water supplies. Other control structures, such as those operated for Saskatchewan Environment and Resource Management and Ducks Unlimited Canada, are generally used to maintain recreational water levels at resort sites or to provide wetland habitat.

The development of drainage works is an important activity in the Basin. The topography is characterized by numerous shallow wetlands, which often collect water from spring runoff but become dry by mid summer. In an effort to assist drainage to enable seeding of these low areas, drainage activity via group projects and individuals works are common. Agricultural drainage in the Basin dates from the early 1900's.

SURFACE WATER USE

Municipal and Domestic

Water use falls into two categories — instream or non-consumptive use and either offstream or onstream consumptive use. Offstream water uses withdraw water from its source, and generally return some of it after use. Major offstream uses are in the municipal, domestic and agricultural sectors. Instream water uses include those of fish, wildlife and recreation. Water quality is usually not affected by instream uses. Evaporation from reservoirs and dugouts form the largest onstream consumptive use of water in the Basin.

Municipal water use includes cities, towns, villages and hamlets serviced by distribution systems. Commercial and industrial users which are serviced by municipal lines are considered municipal water uses. In addition, there are a number of parks facilities with licensed water allocations which are also categorized as municipal water users for this Study. The total current annual use is estimated to be about 4,940 dam^3, of which 80 percent is groundwater. There are 27 communities in the Basin that have water systems, serving populations from 21 to over 15,000. The usage by community is shown in ***Table 5: Municipal Water Use in the Assiniboine Basin***.

Municipal water use is highly seasonal. The highest monthly pumpages are recorded during the summer months. August is typically the month of greatest water usage. This monthly variation can be linked to residential use for lawn and garden irrigation. Domestic water use includes households that employ private water supplies, chiefly farmsteads and households in small communities that are not serviced by a municipal system. These users are generally responsible for their own water supply. Sources may include a deep or shallow well, a lake, stream, river or on-farm storage pond or dugout, a cistern which captures rainwater or holds hauled water, or a local water pipeline.

Table 5: Municipal Water Use in the Assiniboine River Basin

Community	Source	Water Use (dam³/y)	
		1998	5Yr. Ave. (1994-1998)
Badgerdale (Cote)	SW	3.1*	3.1*
Bredenbury	GW	46.3	47.3
Buchanan	GW	61.2*	61.2*
Calder	GW	13.3	3.3
Canora	SW	280	278
Churchbridge	GW	107*	107.1
Ebenezer	GW/SW	16.7	17.5
Endeavour	GW	66.7	53.0*
Fenwood	GW/SW	3.4	3.7
Gerald	GW	16.8	17.2
Hyas	GW	24.7	21.2
Insinger	GW	6.7	6.8
Invermay	GW	43.2	39.4
Jedburgh	GW	1.9	1.7
Kamsack	SW	315	279
Ketchen	SW	1.5*	1.5*
Kuroki	SW	8.9	9.3
Langenburg	GW	153	155
Lintlaw	GW	45.8	42.7
MacNutt	GW	12.2	12.7
Margo	GW	25	27.4
Melville	GW/SW	643	653
Mikado	SW	5.2	5.5
Preeceville	GW	206	212
Rama	SW	9	8.7
Rhein	GW	13	22.5
Saltcoats	GW	102	82.5
Sheho	GW/SW	26.8	30.3
Springside	GW	63	60.4
Spy Hill	GW	39.5	37.6
Stenen	GW	16.6	15.9
Sturgis	GW	134	149
Tadmore	GW	2.2	2.3
Theodore	GW	123	97.3
Togo	GW	24.3	23.1
Veregin	GW	8.8	8.2
White Spruce	GW	12	12
Willowbrook	GW	6*	6*
Wroxton	GW	7.4	6.3
Yorkton	GW	2114	2156
Hamlets¹	GW	55*	55*
Parks Facilities¹	GW	41*	41*
SASKATCHEWAN TOTALS		4635	4627

Agricultural

Water used for agriculture includes rural domestic, livestock, crop spraying, irrigation and evaporative losses from dugouts. Current annual water use for agricultural purposes is estimated to be 8,470 dam³. Rural domestic use is water supplied to farm residences by dugout, well, water hauling or rural pipeline.

The Basin supports both small-scale and intensive livestock operations. Most livestock water use is for non-intensive livestock operations, although there are new intensive operations being proposed, mainly for hog production.

A significant amount of water is used in the Basin for crop spraying. Cropland may receive one to four applications of pesticides and desiccants during the growing season. There are about 95 backflood and sprinkler irrigation projects in the Basin. Dugout use in the Basin is primarily for livestock watering, but it may also be used for rural domestic purposes (household or yard) and for spraying. Calculating the evaporative loss is an important factor in determining overall agricultural use of water in the Basin. This use is estimated to be 2,140 dam³ per year.

Industrial

The industrial use sector refers to those facilities which require significant quantities of water (in excess of four dam³ per year), supplied by a non-municipal source. There are nine licensed industrial water users involved largely in mineral extraction, petroleum, food production and food processing. These water users are collectively allocated about 3,350 dam³ of water annually. All of the water for industrial use is derived from groundwater.

Wildlife Conservation Projects and Environmental Water Use

The Basin's water supply sustains 57 wildlife conservation projects which have water allocation licenses. These projects are granted allocations that total 16,640 dam³ of water annually. All of the water is derived from surface water sources. These works provide an abundance of natural habitat for many different species.

Wildlife conservation projects are usually natural wetlands with a control structure operated to facilitate waterfowl needs. The licensed allocation for those projects is the total evaporative loss from the surface area of the wetlands, much of which would have occurred under natural conditions. Without a detailed analysis of every project, the cumulative effect of the projects on Basin water use is not known. Therefore, the net water use of the projects is assumed to be negligible.

While fish habitat is recognized as an important instream use of the Basin's water bodies, the requirements for instream flow needs have not yet been completely identified. The Assiniboine River upstream of Lake of the Prairies is a significant spawning area for walleye. Pike, perch and walleye can be found in larger lakes scattered throughout the Basin.

Regulated Lakes and Reservoir Evaporation

Reservoirs in the Basin include Good Spirit Lake and Theodore Reservoir, with smaller ones at the Canora and Kamsack weirs. The average annual net evaporation from these four reservoirs is estimated to be negative (annual net precipitation is greater than annual net evaporation). The negative value of average annual net evaporation in Saskatchewan is due to large evaporation from Good Spirit Lake. The installation of a control structure in the late 1980s at Good Spirit Lake resulted in the lake being operated at a lower full supply level (FSL) than under natural conditions. The lower FSL decreased the surface area of the lake so there is currently less evaporation under regulated conditions and the net evaporation change due to the project is negative.

Apportionment Water Requirement

As an interprovincial watercourse, the Assiniboine River is subject to the terms and conditions of the 1969 Master Agreement on Apportionment, which applies to all eastward flowing interprovincial streams in Alberta, Saskatchewan and Manitoba. The agreement is administered by the Prairie Provinces Water Board, whose members represent the governments of Canada, Alberta, Saskatchewan and Manitoba.

In general, the agreement provides that each province must pass to its downstream neighbor at least 50 percent of the stream's natural flow which arises in that province plus 50 percent of the natural flow from the upstream province. Natural flow is that flow which would have occurred prior to any water resources development. In the Study area, the apportionment obligation for the Assiniboine River amounts to 50 percent of the natural flow at the interprovincial boundary. Since there are no large water use projects on the Assiniboine River being planned in Saskatchewan, apportionment of the Assiniboine River will not be an issue in the immediate future.

The mean annual natural flow of the Assiniboine River amounts to 265,000 dam^3. The apportionment value would be 50 percent which translates to a volume of 132,500 dam^3. This value exceeds by far all of the other combined withdrawal uses.

The following table summarizes the annual uses. Note the total withdrawal is calculated to be 33,040 dam^3, compared to the apportionment volume of 132,500 dam^3. ***Figure 27: Water Use by Category*** depicts the amount of water by usages and also compares to Manitoba. ***Figure 28: Licensed Water Uses in the Assiniboine River*** is a map showing the location of all licensed users.

Table 6: Summary of Present Annual Withdrawal Uses

Type of Use (% of Total Use)		Saskatchewan (dam³)		
		SW	GW	Total
Municipal (9%)	Recreation	0	40	40
	Urban Distribution	970	3930	4900
	Total Mun.	970	3970	4940
Agriculture (19%)	Irrigation	2120	30	2150
	Livestock			2540
	Domestic			1400
	Spraying			240
	Evaporation	2140		2140
	Total Ag.			8470
Industrial (6%)	Food Processing	0	30	30
	[illegible] Washing	0	1940	1940
	Mining	0	1380	1380
	Total Ind.	0	3350	3350
Wildlife Conservation (50%)		16640	0	16640
Reservoir Evaporation (38%)		-360	0	-360
Grand Totals				33040

Note: May not add exactly due to rounding.
SW - surface water
GW - groundwater

Figure 27: Water Use by Category

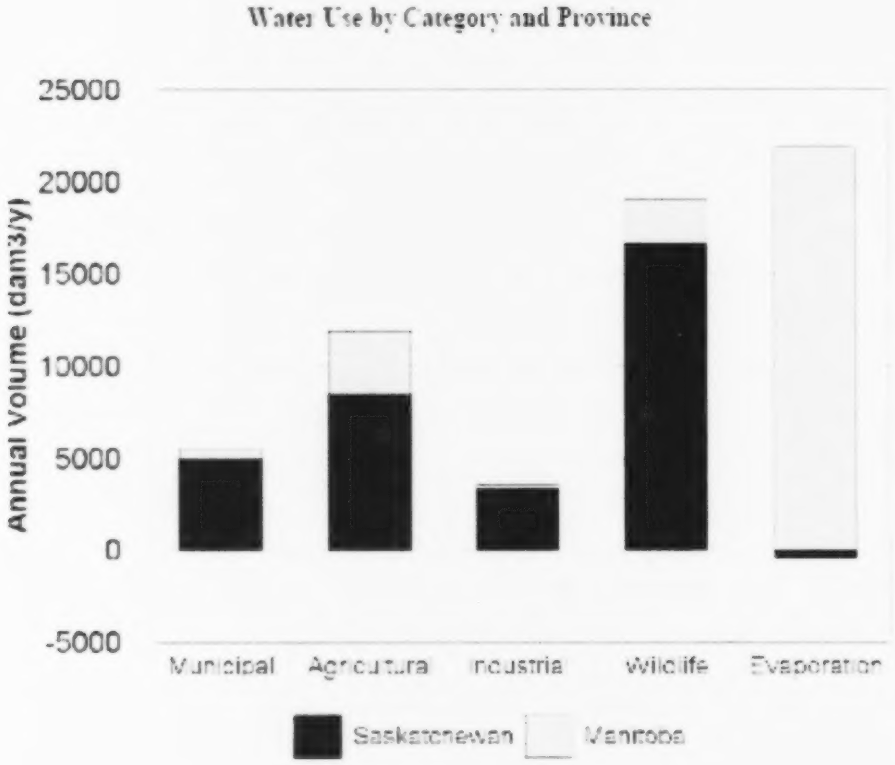
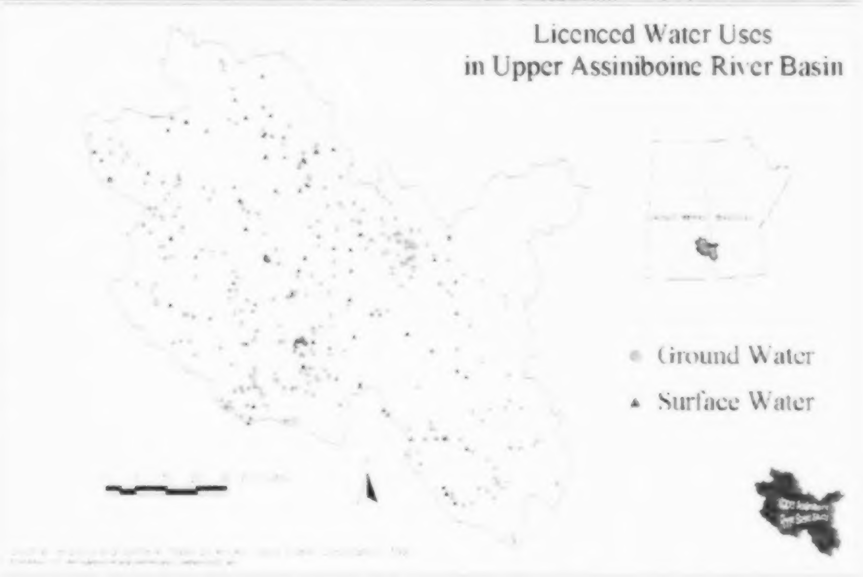


Figure 28: Licensed Water Uses in the Assiniboine River Basin



4.2 Groundwater Resources

Geology

In contrast to surface water, groundwater in the Basin is less prone to short term precipitation extremes and thus as a supply it is more consistent. However, groundwater supplies are typically less able to provide large quantities of water at any given location. Groundwater can be considered contained in one of two general geologic deposits; bedrock and glacial. Aquifers in bedrock are deeper and tend to be more extensive in area than those in glacial deposits. For purposes here, glacial aquifers occur as buried valleys, intertill or surficial aquifers. Groundwater supplies not in surficial aquifers are insulated from drought conditions at surface, while even surficial aquifers may offer some measure of drought resistance because of the storage in the aquifer.,

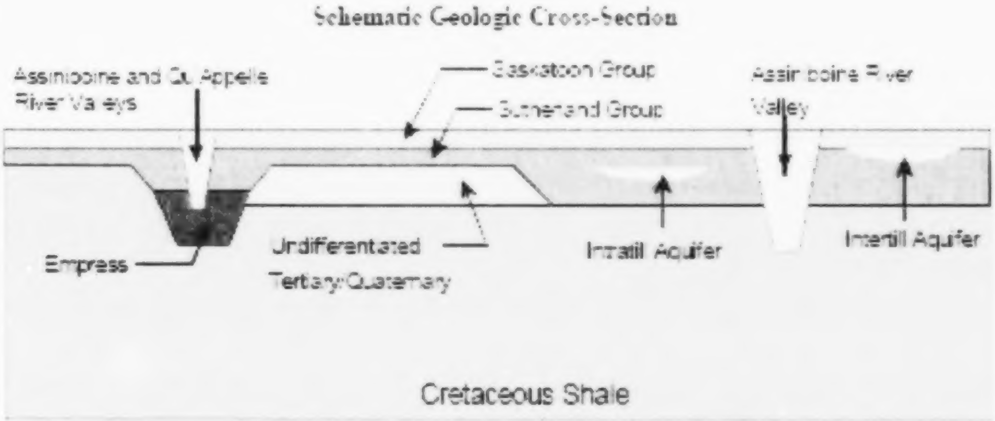
Available groundwater supply, unlike surface water supply, cannot be directly measured. Therefore, defining the groundwater supply is more involved, arduous and costly than doing the same for surface water. The complete characterization of groundwater resources, even for a simple system, requires significant amounts of data and skilled data interpretation. For an area as large and hydrogeologically complex as the Upper Assiniboine River Basin, a complete characterization would require great amounts of data and equal amounts of skilled data interpretation, resulting in a very expensive effort. Thus, this hasn't been accomplished as yet and there are no plans to do so in the foreseeable future. However, considerable mapping has been completed providing the mapping framework to understand groundwater. This mapping continues to be developed and periodically improved, although in an ad-hoc fashion.

Groundwater resources in the Assiniboine River Watershed are classified as both bedrock and quaternary aquifers. Bedrock aquifers are composed of sands of the Mannville/Swan River Formation and Undifferentiated Tertiary-Quaternary sands. The saturated sands of the Tertiary-Quaternary sediments consist of the Bredenbury, Otthon, and Willowbrook aquifers. These aquifers range in thickness from 20 to 30 meters, overlain by 20 to 130 meters of till. The Bredenbury and Otthon aquifers are hydraulically connected to the Hatfield Valley aquifer system.

Aquifers in the glacial deposits are formed in buried valleys, intertill, and surficial deposits. Buried valley aquifers in the watershed include the Hatfield Valley, Basal, Melville, and Rocanville aquifer systems. The Hatfield Valley aquifer system is the most extensive in the area and extends into Manitoba. It is one of the largest buried preglacial valleys in Saskatchewan. Typical thickness of the Hatfield Valley aquifer is 50 meters, overlain by approximately 50 meters of till. The Melville and Basal aquifers occur above the "shoulder" of the Hatfield Valley, with an estimated thickness of 20 to 30 meters. The Rocanville aquifer ranges in thickness from 10 to 125 meters, overlain by 75 to 150 meters of glacial drift.

Intertill and surficial aquifers are characterized as discontinuous sands and gravels. Intertill aquifers are confined above and below by till deposits. These types of aquifers are referred to as undifferentiated inter-till and intra-till aquifers. The spatial extent, distribution, and thickness of these aquifers are variable. These aquifers provide an important source of water for both domestic and municipal purposes. For example, the City of Yorkton production wells are mostly completed in the inter- and intra-till aquifers. Surficial and alluvial aquifers include sand and gravel lenses and alluvial deposits. The major alluvial deposits are related to the Qu'Appelle and Assiniboine river valleys.

Figure 29: Schematic Geologic Cross-Section


Schematic Geologic Cross-Section
Assiniboine and Qu'Appelle River Valleys
Saskatoon Group
Sutherland Group
Assiniboine River Valley
Empress
Undifferentiated Tertiary/Quaternary
Intratill Aquifer
Intertill Aquifer
Cretaceous Shale

The above figure shows a schematic cross-section of the Basin geology in a greatly simplified form to demonstrate the vertical profile according to the Saskatchewan stratigraphic setting from the Late Cretaceous Period to the present. The entire Basin is underlain by Cretaceous shales which form the bedrock surface in most of the area. In the few areas where remnants of undifferentiated Tertiary-Quaternary sediments remain, they form the bedrock surface. Based on the Saskatchewan stratigraphy, glacial drift in the Basin can be subdivided into three groups which are the Empress, Sutherland and Saskatoon groups in ascending order.

Prior to the first glaciation, the Hatfield Valley was formed by fluvial erosion and deposition of Empress Group sediments. The Quaternary Period included both deposition and erosion, as several continental glaciations occurred which had a profound effect on the landscape. Till units of the Sutherland and Saskatoon groups were deposited during successive glacial stages. Stratified sediments, including the sands and silts forming many of the aquifers in the Basin, were deposited during intraglacial, interglacial, and proglacial stages.

Figures 30 to 35 inclusive depict the various aquifer structures known within the Basin.

Figure 30: Bedrock Aquifers formed by the Empress Group

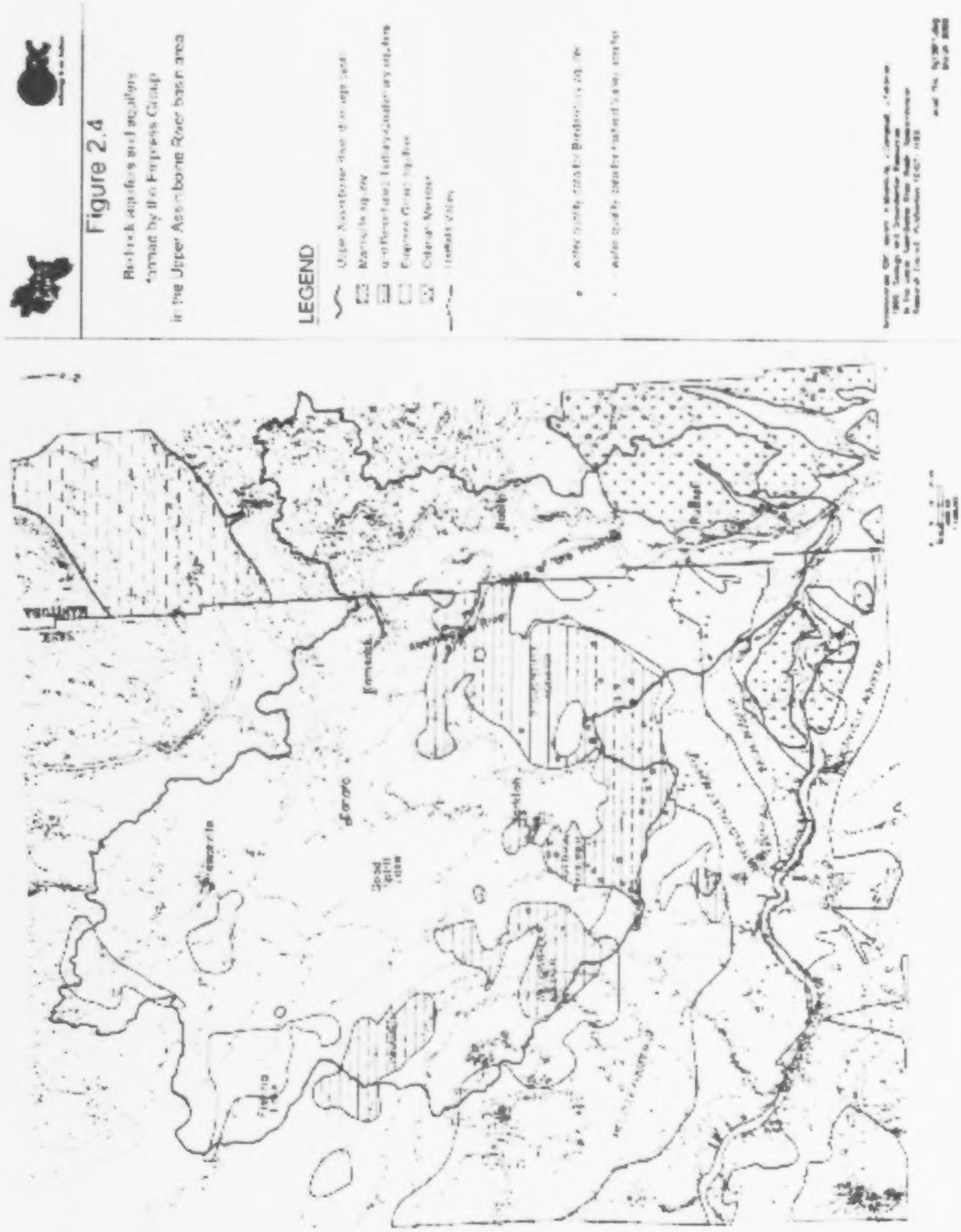


Figure 2.4
Bedrock aquifers and aquifers formed by the Empress Group
in the Upper Assiniboine River basin area
LEGEND
Upper Assiniboine River drainage basin
Empress Group aquifer
Hatfield Valley
water quality data for Bredenbury aquifer
water quality data for Hatfield Valley aquifer
Preeceville
Fishing Lake
Canora
Good Spirit Lake
Kamsack
Yorkton
Roblin
Russell

Figure 31: Aquifers within the Sutherland Group

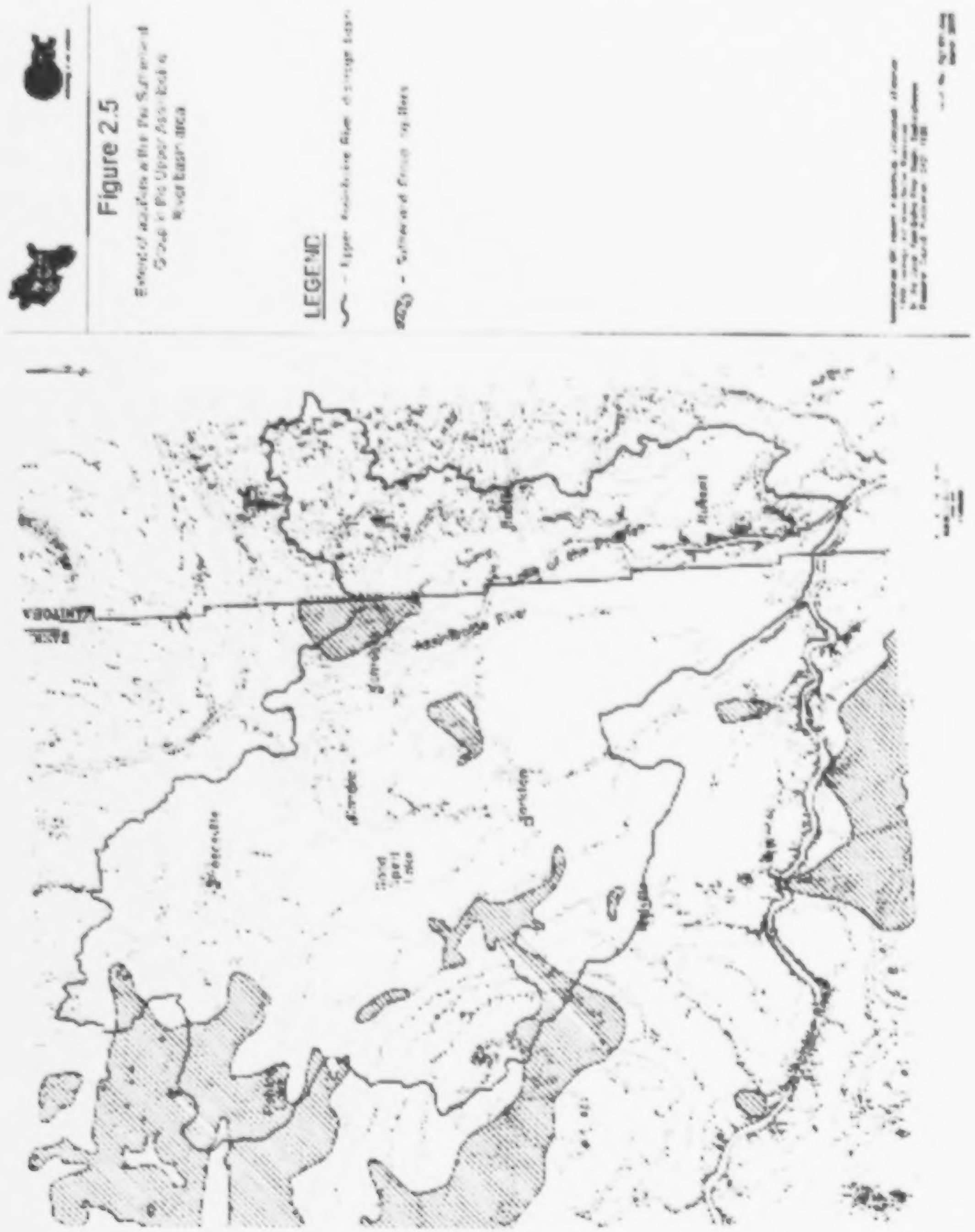


Figure 2.5
Extent of aquifers within the Sutherland Group in the Upper Assiniboine River basin area
LEGEND
– Upper Assiniboine River drainage basin
– Sutherland Group aquifers
SASK.
MANITOBA
Preeceville
Canora
Kamsack
Good Spirit Lake
Yorkton
Melville
Russell
Assiniboine River

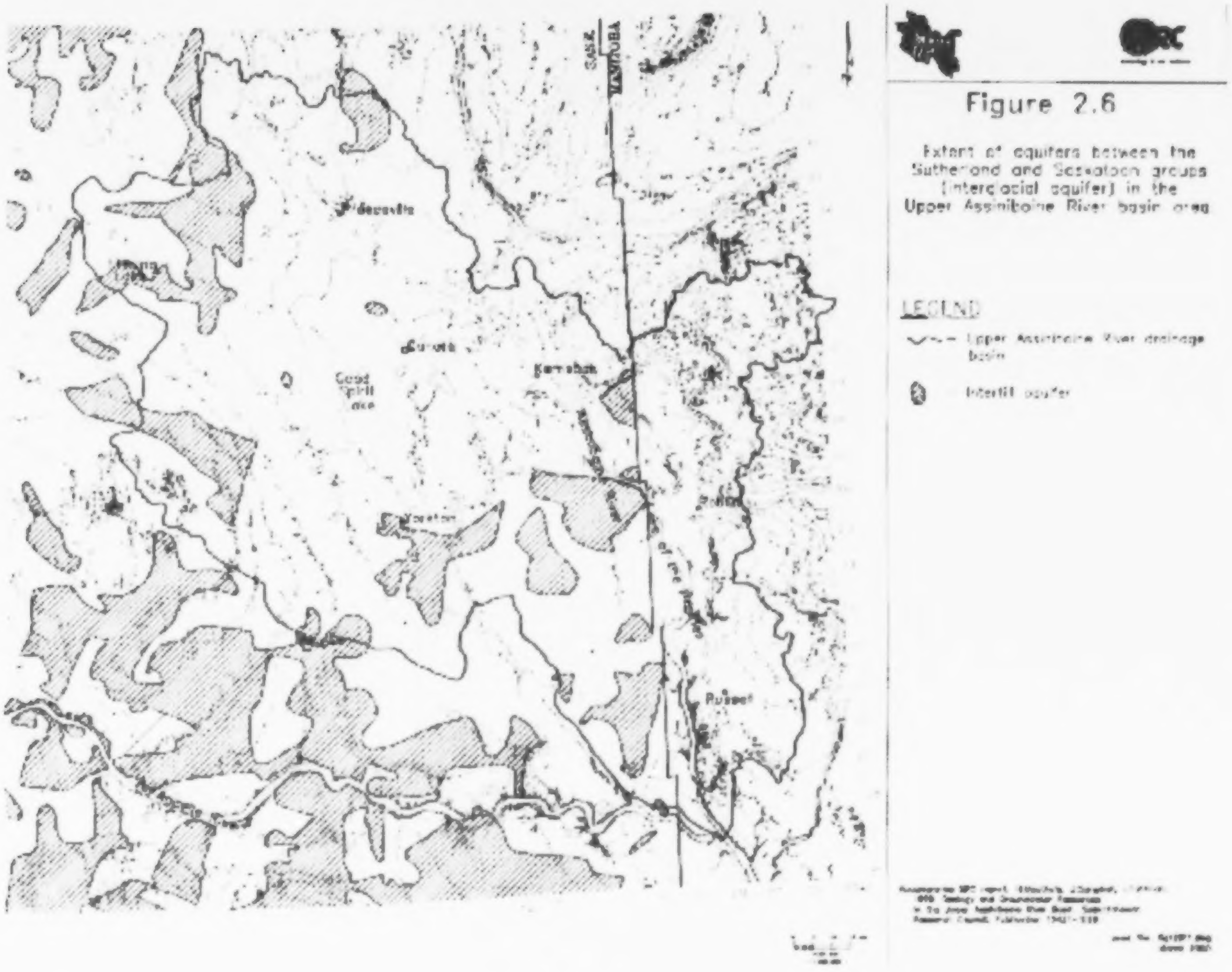


Figure 2.6
Extent of aquifers between the Sutherland and Saskatoon groups (interglacial aquifer) in the Upper Assiniboine River basin area
LEGEND
Upper Assiniboine River drainage basin
Intertill aquifer
Sask.
MANITOBA
Yorkton
Kamsack
Good Spirit Lake
Russell

Figure 32: Aquifers between the Sutherland and Saskatoon Groups

Figure 33: Aquifers within the Saskatoon Group

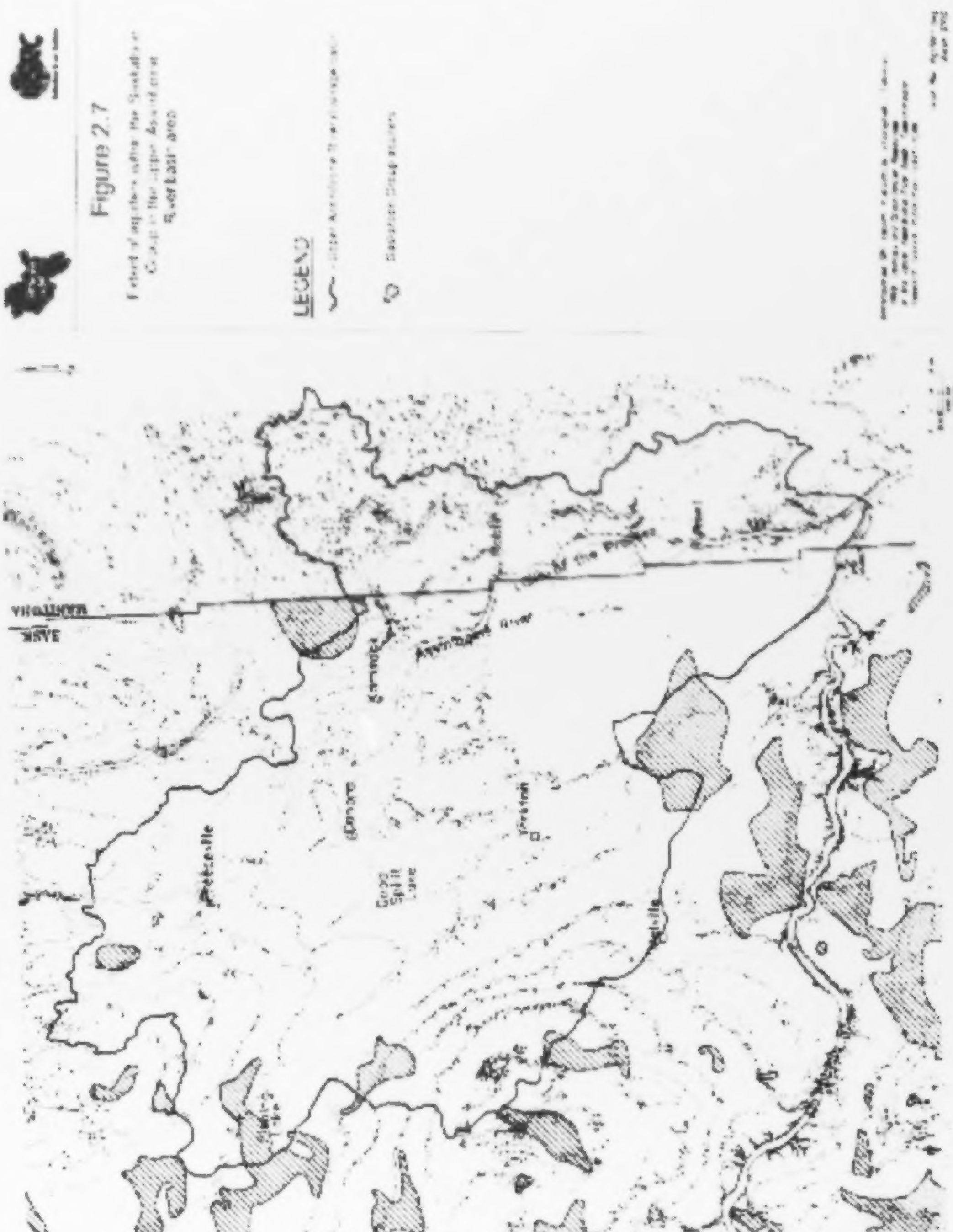


Figure 2.7
LEGEND
MANITOBA
SASK.
Assiniboine River
Good Spirit Lake

Figure 34: Surficial and Alluvial Aquifers in the Basin

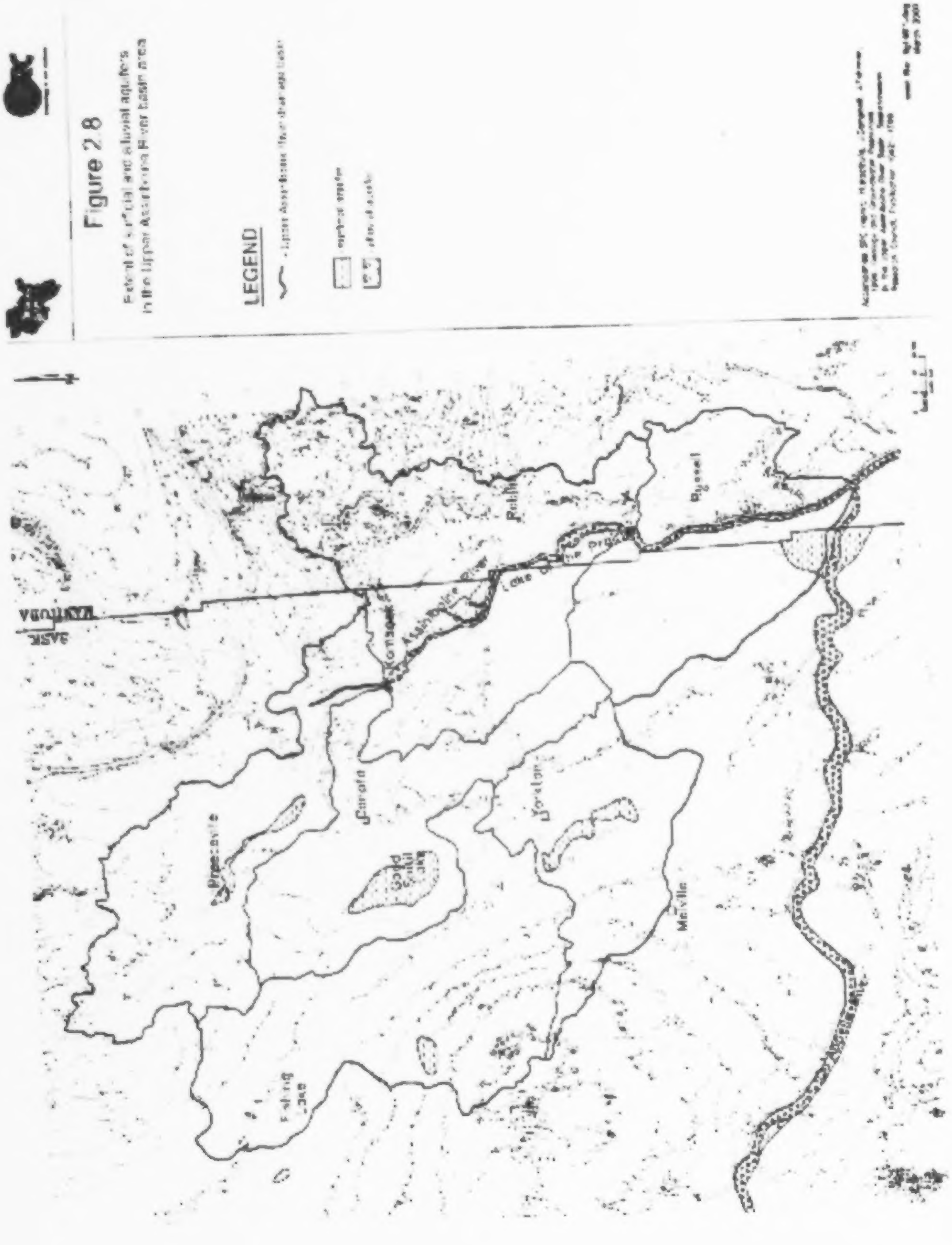


Figure 2.8
Extent of surficial and alluvial aquifers in the Upper Assiniboine River basin area
LEGEND
Upper Assiniboine River drainage basin
surficial aquifer
alluvial aquifer
SASK.
MANITOBA
Preeceville
Fishing Lake
Canora
Good Spirit Lake
Kamsack
Yorkton
Roblin
Melville
Russell
Lake of the Prairies

Groundwater Quality

Water quality in the Bredenbury aquifer is variable. In general, the water is marginally acceptable for municipal use, but treatment for iron and manganese is required. The water is typically acceptable for livestock use, but suitability for irrigation varies from one location to another. Water quality in the Hatfield Valley aquifer is considered poor and thus limits its use.

Intertill and surficial aquifer water quality is generally superior to bedrock or other deeper aquifers. However, it is susceptible to drought and contamination, due largely to the comparatively rapid recharge rate common to the surficial aquifers.

The water quality ranges applied to specific formations are based on data from a variety of sources but have been used only when the existing literature has indicated which formation the analysis represents. The data in the following table summarizes the data available in the supplementary report, and shows that water quality in all formations is extremely variable.

Table 7: Summary of Mapped Regional Aquifers

Type of Aquifer		**Major Aquifer:**	**Occurrence in UARB**	**Specific: Well Yield:**	**General Water Quality (sum of ion, mg/l)**
Quaternary	Surficial Alluvial	Numerous	Various locations		
	Drift Aquifers	Numerous	Various locations		
	Empress Group	Hatfield Valley	Southeast corner	0-80 m thick	variable 1000 to 4000
		Basal	Extreme southeast	20 m thick	
		Melville	Extreme south	30 m thick	
		Others	Various locations		
Bedrock Aquifers	Undifferentiated Tertiary Quaternary	Bredenbury	Southern portion		variable 800 to 3000
		Otton	Southern portion		
		Willowbrook	Southern portion		
	Cretaceous silts and clays	Odanah	Extreme southeast corner	up to1 l min MB	variable 500-2800
		Mannville	Used only in extreme northeast underlies most of Study area	40-150 m thick up to8 l min MB	variable

Groundwater Yields

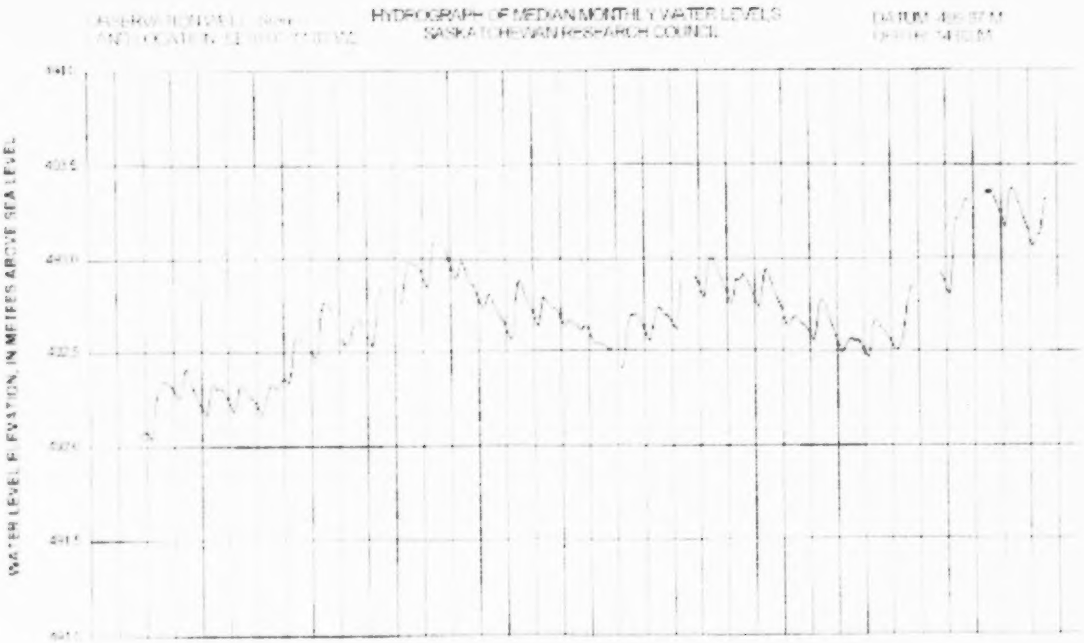
The Hatfield Valley aquifer system is a major source of groundwater. It consists of a series of inter-connected aquifers located in the southern portion of the Basin, including the Bredenbury, Wynyard-Melville, Willowbrook and Hatfield Valley components. Of these, the Bredenbury aquifer underlies the largest portion of the Study area (3,300 km²). It is comprised of the Bredenbury Formation sands and silts which extend from the Yorkton area in a southeasterly direction. The aquifer thickness averages about 25 metres. The aquifer is hydraulically connected to the Hatfield Valley and Melville aquifers, and possibly to the course-grained glacial deposits around the cities of Yorkton and Melville.

The net annual yield of the Bredenbury aquifer, based on precipitation recharge, has been estimated at between 35,000 and 58,000 dam³. The maximum yield of a single well is in the order of 135 m³ per day. It has been estimated that wells would have to be spaced at three kilometer intervals in order to avoid unacceptable drawdown interferences.

The Hatfield Valley aquifer underlies an area of about 450 km² in the southern portion of the Basin. It is part of the largest and most important buried preglacial valley in Saskatchewan. The Hatfield Valley aquifer runs diagonally from west of the Alberta-Saskatchewan border across Saskatchewan and on into southwestern Manitoba. It is up to 30 kilometres wide, about 550 km in length, and 30 to 50 metres thick. The annual yield of the portion of the Hatfield Valley aquifer located in the Basin is estimated at 7,000 dam³.

Water level fluctuations which are characteristic of the natural behavior of groundwater levels within the Study area are reflected in the data from observation well SRC Stenen shown in ***Figure 35: Monitoring Well SRC Stenen Hydrograph***. Groundwater levels naturally rise and fall during different periods due to the overall hydrologic conditions. Levels have generally been rising since the early 1990s.

Figure 35: Monitoring Well SRC Stenen Hydrograph



5. Current Watershed Management Issues/Considerations

The Upper Assiniboine River Basin reports were utilized extensively to prepare a list of the concerns related to source water protection. All of the UARB study issues were reviewed within the context of a 'source water protection' perspective. One of the initial areas of concern raised by the Technical Committee was that the health of the watershed has other implications, such as wildlife values.

For the purpose of this planning process, it was concluded that the focus must be on source water protection and those aspects of the ecosystem that are strongly linked to this aspect. If a protection strategy also has a benefit to wildlife it is an additional advantage but the focus of the planning was not to be habitat orientated. It should be stressed that wildlife and habitat can be ideal indicators of ecosystem health and the ability of the watershed to provide quality water for human use.

It was decided to organize the UARB "water quality" issues or concerns separately from "watershed health or wildlife" issues that are related to water quality as an initial step. Other considerations or issues raised by the Advisory Committees were later added to the process. The following section summarizes aspects related to specific watershed considerations or issues pertaining to source water.

5.1 Water Quality Related

5.1.1 Watershed residents perceive that groundwater and surface water quality is deteriorating and must be protected by measures such as increased monitoring.

Surface Water

Periodic sampling has been conducted in the watershed as part of specific studies on major water bodies including Fishing Lake, Good Spirit Lake, Whitesand River, Assiniboine River, Shell River, Big Boggy Creek, and Lake of the Prairies. Water supplies and wastewater from towns and cities are also sampled as part of regulated treatment operations. In addition to these studies, monitoring conducted on the Assiniboine River below Kamsack at the Prairie Provinces Water Board station near the interprovincial boundary provides the most comprehensive information on the watershed.

Water quality data has been collected at Kamsack on a monthly basis since 1974. Data from this site was analyzed for long term trends over the past 17 years. The resulting report, "Water Quality Trends in the Assiniboine River at the Interprovincial Boundary", shows no constituent had any significant long-term increasing water quality trend. Long-term decreasing trends were determined for nickel, fecal coliform and the insecticide alpha BHC. However, variables such as total phosphorus, dissolved oxygen and total manganese exceeded the PPWB water quality objectives, and were identified as a potential concern.

Groundwater

Monitoring wells for a range of constituents such as pesticides, nitrates, or bacteria contributes to addressing immediate concerns over the protection of groundwater supplies. Contaminants may move slowly through soil, depending on the permeability of the materials. How quickly a contaminant moves through the overlying material to the aquifer can affect how quickly it is detected in a water supply. In the future, regular monitoring of wells should be encouraged and would be a prudent course of action for early detection of potential problems.

Groundwater is normally the first choice of water supply for rural residents where it is available in sufficient quantity and quality. Groundwater quality is much more uniform throughout the year than is surface water quality, allowing for consistent water treatment where treatment is needed.

However, in many parts of the watershed, the quantities of groundwater available are not adequate to supply domestic wells, or the chemistry of some shallow groundwater supplies makes it unsuitable for consumption. In these areas, many residents depend on dugouts for farm and household use. Dugouts are drought sensitive and prone to water quality problems due to the nature of the runoff which fills them.

Groundwater protection from man-made sources of contamination may be enhanced through measures such as proper well sighting and well construction, sealing abandoned wells, testing well water and taking steps to prevent contamination in recharge areas. Until specific groundwater recharge information is available for a particular parcel of land, landowners should be encouraged to use land management practices that have a positive affect on maintaining good quality water. Where natural groundwater is hard or contains high concentrations of sodium or sulphate, home-scale water treatment may or may not be feasible.

If a surface water supply source is used, water quality can be enhanced by protecting the quality of runoff into the dugout or stream. Runoff into dugouts should be filtered by vegetation to minimize sediment and sediment-borne contaminants and nutrients. In a similar manner, vegetated riparian zones along streams help to maintain stream water quality. Livestock should be kept away from dugouts to avoid contamination of the water.

5.1.2 Rural residents are concerned about access to good quality domestic and drinking water supplies, and availability of low-cost testing services.

Water quality tests should be conducted regularly on domestic supplies. However, the costs of water quality testing to the individual are in some cases a deterrent to regular water quality monitoring. The onus is usually on the individual to take the sample, request the type of information desired and pay a provincial or private laboratory the full price for analysis. Then, it is up to the individual to interpret the results and to determine a possible course of action.

In Saskatchewan, the Saskatchewan Watershed Authority has initiated a program to encourage water quality testing for individual rural domestic water supplies (including dugouts and wells) for a subsidized fee (currently $100). A technician will sample and arrange for analysis of the raw water for major ions, bacteria, nutrients, physical parameters, trace.

5.1.3 Domestic and municipal groundwater supplies need to be protected from contamination.

Many communities and rural residents rely on groundwater as their sole source of potable water, and they are concerned about the quality of these water supplies and the potential for contamination. Protecting supplies from the infiltration of agricultural chemicals is of particular concern for shallow wells.

Groundwater quality can be impacted by activities such as fertilizer and pesticide applications, manure storage and spreading, livestock operations, effluent irrigation, leaking septic tanks, landfill leachates and lagoon seepage. Once contaminants enter groundwater supplies, they have the potential to impair the water quality for municipal, domestic, irrigation and livestock purposes.

Remediation of contaminated groundwater supplies is often difficult, time consuming and expensive. Prevention is the only effective approach to dealing with the potential for groundwater contamination.

Methods for protecting groundwater supplies include proper well citing and construction, protection from potential contaminants in the recharge area, adopting best management practices to reduce non-point contamination from agricultural sources, monitoring, and the proper decommissioning of unused wells.

Although groundwater contamination has been observed at some specific locations within the watershed, it is presently not considered to be a widespread problem.

5.1.4 Chemical Container disposal areas and landfill operations are point sources of pollution that can affect surface and groundwater quality. These operations must be properly managed and enforced.

Chemical container disposal areas and landfills are potentially significant point sources of pollution in rural areas.

An initiative to collect and recycle pesticide containers has been managed by the Crop Protection Institute of Canada for a number of years. Proper chemical container disposal includes triple rinsing the containers, disposal at an authorized, properly designed facility, and recycling of the disposed container in an approved manner.

However, not all containers are discarded in the proper manner. Containers which are improperly discarded in municipal waste disposal grounds or at their point of use pose a contamination hazard for both surface and groundwater.

Municipal and private waste disposal grounds or landfills must comply with regulations which govern the type of material which can be accepted. Proper site location, construction and maintenance is required to protect groundwater supplies from leachate and surface water supplies from direct contamination. Older waste disposal areas which do not comply with the current regulations may contaminate groundwater or surface water with agricultural or household chemicals, petroleum products or organic contaminants such as manure or dead livestock.

These non-compliant disposal areas include unauthorized on-farm disposal areas. Disposal areas which do not comply must be closed and cleaned up to prevent the migration of contaminants through water flows.

Continued public education is needed to increase the recovery rate for chemical containers. This may be combined with incentives such as deposits on the containers, and with enforcement action to prevent improper disposal practices. Public education concerning the need to dispose of containers at approved municipal waste disposal grounds is also appropriate.

5.1.5 Agricultural drainage from farm land, sloughs and wetlands can be a non-point source of pollution for surface water. Agricultural runoff may contain increased sediment, nutrients and pesticides.

Non-point contamination from agricultural runoff is a particular concern in the Assiniboine River Watershed. Sediment levels are generally higher in runoff from agricultural land than from natural areas. Nutrients, in the form of either manure or artificial fertilizers, may bind to sediment or dissolve in runoff water. Pesticides from cropland may also move with runoff water.

Minimizing water-borne contamination from agricultural land would satisfy environmental concerns and the interests of landowners. The appropriate application of fertilizers and pesticides is key to reducing contamination from agricultural runoff.

Proper planning of agricultural drainage projects is also necessary to reduce channel erosion and to retain or establish riparian buffers to filter the water entering the drainage system. As part of the project planning, economic and environmental justification should be considered, with avoidance examined as an option.

Planning should also identify land parcels which should not be developed for agricultural use due to their higher value for other purposes.

Water quality initiatives involving agricultural land must rely on public education and demonstration projects. Wetland restoration has been recently approved as an activity under some of the Best Management Practices for initiatives such as Environmental Farm Planning.

5.1.6 Algal blooms on Lake of the Prairies are a concern.

Nutrients, light, wind (which mixes water), and temperature are the primary factors affecting the formation of algal blooms in lakes. These factors strongly influence the type of algae that grows and the size of the bloom. Of these factors, nutrients are the only factor over which some reasonable control can be exerted. Although many of the nutrients entering Lake of the Prairies occur naturally, nutrients originating from agricultural runoff also enter the lake.

Sound agricultural practices and riparian zone management upstream of the lake can minimize the loss of nutrients from agricultural land and their introduction to the lake.

5.1.7 Livestock operations and range management practices deteriorate water quality and impact downstream users.

As the size and numbers of livestock operations in the watershed increase, concerns have been expressed that livestock operations will deteriorate surface water and groundwater quality. There is evidence that overwintering of cattle on watercourses or direct watering from streams, rivers, or lakes can deteriorate water quality by increasing nutrients, soil bank erosion, sedimentation, pathogens, and degrading riparian areas.

Further concern has been raised over the proper storage and disposal of manure and the prevention of runoff from pens in intensive livestock operations.

Through a variety of programs and incentives provided in recent years, agricultural producers have begun to implement beneficial riparian management projects, including restricted livestock access to rivers and lakes, off-stream watering facilities and managed grazing projects. These projects have provided benefits to the producers and the environment.

Much of this work to date has been conducted through public education and demonstration projects. For example, eight livestock producers with operations near the Whitesand River and one of its tributaries are participating in a riparian enhancement program supported by the National Soil and Water Conservation Program. The project has incorporated several activities such as the establishment of vegetative buffer strips, conversion of cropland to forages, off-stream watering, rotational grazing management planning, and relocation of livestock wintering sites away from the river.

5.1.8 Municipal lagoon operations, sewage treatment and effluent disposal can impact water quality and must be strictly managed.

While the larger urban centers may operate sewage treatment plants, most small towns and communities in the watershed rely on lagoons as their primary effluent treatment system. Watershed residents are concerned about the impacts of sewage effluent discharges into rivers and streams and the impact this may have on water quality for downstream users.

Municipal wastewater treatment systems are composed of a primary cell and one or more secondary storage cells. In the primary cell, heavy organic material settles out, while the lighter organic material remains suspended. In the secondary cell, biological organisms break down the organic material to help purify the effluent. The decomposition processes in the secondary cell are usually a combination of anaerobic and aerobic processes.

Municipal wastewater treatment facilities require a permit or licence to operate. Provincial regulations specify when lagoon systems can be discharged, and also set objectives for minimum effluent quality to minimize the impacts on receiving water bodies and fish habitat.

Typically, lagoons are licensed to discharge once or twice a year; some never discharge, while some larger mechanical treatment plant facilities such as Yorkton's continuously discharge.

Lagoons can be potential sources of pollutants including nutrients, heavy metals, pathogens, and a variety of industrial and hydrocarbon chemicals.

Groundwater supplies may also be impacted where leachates from lagoons migrate to the water table. The integrity of lagoons and septic systems needs to be maintained and monitored to prevent seepage to groundwater supplies.

5.1.9 Urban stormwater runoff may be affecting the water quality of rivers and streams downstream of communities.

Snowmelt and rainfall events that occur in urban areas result in surface runoff, termed 'urban stormwater runoff'. It is transported by stormwater sewers and drainage channels to streams and rivers downstream of these communities. As the runoff travels across and through the urban area it becomes degraded by a variety of contaminants. Examples of these are: suspended solids, chloride, petroleum products, trace metals, fertilizers, pesticides, herbicides, pathogens, and microorganisms. Urban runoff has been recognized to cause significant environmental impacts for the past 30 years. In certain situations urban stormwater runoff volume is greater than that from wastewater treatment plants. Stormwater can also have greater suspended solid loads than effluent from wastewater treatment plants.

These can result in the deterioration on the water quality of the streams and rivers receiving the urban stormwater runoff. In addition, there can be a negative impact on aquatic life in these waters. All components of the aquatic ecosystem can be affected. Impacts on water quality and aquatic habitats will also be subjected to cumulative effects.

Urban stormwater is not specifically regulated by any jurisdiction. In Saskatchewan, exemptions for urban stormwater were removed when *The Water Pollution Control and Waterworks Regulations* were revised in December 2002, becoming *The Water Regulations*, 2002.

Saskatchewan Environment is presently developing a stormwater management "best practices" document. The goal is to have the document drafted by the end of the fiscal year. The next step would be to initiate an internal government review, followed by a public review. This should occur in late 2005 or early 2006.

Urban development within the Assiniboine River watershed is relatively limited. The City of Yorkton is the largest centre, with a population of 17,000 and a land area of about 15.0 km^2. The City of Melville, the next largest centre, has a population of 4,650 and a land area of 15.4 km^2. This is in comparison to the Assiniboine River Watershed area within Saskatchewan of approximately 16,590 km^2.

Even though the urban element is relatively small in size, the impact of urban runoff may be adversely affecting stream reaches in the areas downstream of the larger centres in the watershed.

The water quality of stormwater is highly variable within a runoff event, from event to event and from year to year. It is known that the quality is poorest at the beginning of an event and improves over the duration of the event.

There is limited scientific data available on stormwater runoff for urban centres in Saskatchewan. It is apparent that there is an information gap on this aspect, especially for smaller cities such as Yorkton.

5.1.10 Flooding

Flooding was raised as an issue in that there may be specific situations where development is occurring within the flood plain which may result in potential contamination of source waters.

5.2 Watershed Health Related

5.2.1 The economic and social considerations associated with wetlands and agriculture should be better understood.

A conservation ethic among farmers can be fostered through a combined agricultural and environmental government departmental effort to understand and work towards practical common approaches to the social and economic considerations for land development in the watershed.

Greater emphasis should be placed on community approaches to solving land and water management problems. These actions could bring about harmony between the interests of farmers and environmental protection in a more holistic way, and better define sustainable agriculture.

Criteria should be developed for the classification of wetlands, the identification of environmentally sensitive areas and mitigation for lost habitat. Identification of environmentally sensitive areas is necessary as a basis for directing a variety of programs, including compensation where off-farm drainage is proposed.

As specific land management plans are developed, work would be needed to document remaining wetland and upland habitats and their importance in the watershed and region. This more detailed classification can be done at the smaller scale to provide direction.

A practical way to help identify the remaining habitat that could be protected along with the land for various agricultural uses would be to identify land use in a watershed plan developed with local involvement. Information is available on topography, hydrology, soils, and lands which have some level of conservation protection.

Participants in developing a watershed plan can use this information to better develop an understanding of the resources, and to identify desired directions for development and conservation. The result would be a plan that would identify areas more suited for certain types of development and lands which would be deemed important for some level of conservation management.

A proposed plan for off-farm drainage which impacts wetlands, or channelization in riparian habitats, should include mitigation. Mitigation may involve retaining, improving or restoring habitat to compensate for habitat that may be lost in developing a project that involves land drainage and/or clearing. Including mitigation in a land development plan would be applicable at both the small scale (individual farm) and to a larger-scale proposal (watershed level).

5.2.2 Wetlands and uplands in the watershed are important and should be protected. The continued removal and degradation of the uplands associated with wetlands and riparian areas will place wildlife at risk.

The importance of individual wetlands must be assessed in the context of the neighbouring wetland and upland habitats. Wetland numbers, their characteristics and the vegetation around them vary over time in response to moisture conditions. These changes in wetland habitat result in changes in their use by different species of wildlife. Some species disperse to other areas to breed, others remain but breed in adjacent but less secure habitats, and still others do not breed until suitable conditions return.

Incremental loss of wetland habitat, wetland margins or upland grassland, and shrub or tree cover also has an impact on wildlife. This loss is almost impossible to measure or quantify in terms of the species affected and numbers of individuals displaced or lost.

However, the aggregate of all habitat losses within the watershed, as well as those upland and wetland habitats that have been permanently altered or fragmented, has resulted in less wildlife over the long term. The land base in many cases has been altered to the extent that no wildlife can be produced or live in those areas. There may be periodic increases of species such as white-tailed deer or the Canada goose, but over the long term, the amount of habitat capable of sustaining these and many other species is declining.

Some plant and animal species may be more vulnerable than others to loss and alteration of wetlands. Some species may be able to adapt, at least for a short period of time, through dispersal or use of other types of habitats.

The removal or degradation of upland habitat, such as slough margins and riparian woodlands, can also affect wildlife which use wetlands.

If the health of the landscape is indicated by its biological diversity, continued degradation and loss of wetlands will be an effective barometer.

Many land use activities can impact wetlands and uplands and associated wildlife. Among these are agricultural activities such as burning, clearing, drainage, filling, grazing and haying, and other activities such as road building. Each of these actions can have a major impact on wildlife, particularly when habitat is irrevocably lost.

In an effort to succeed financially, an agricultural producer must manage the land base to achieve its maximum agricultural potential. New agricultural technologies continue to make production more efficient. Although this is beneficial to the producer, it is not a complete solution. Land use is constantly changing as the conditions that affect agriculture change. For example, Statistics Canada information reveals that the average farm size in the watershed increased from 404 acres in 1956 to 854 acres (164 to 346 ha) in 1996. Over the same period, the rural population declined from about 57,000 to 23,000.

Agricultural policies have had a great impact on land use and agricultural practices within the watershed. The intent of many earlier agricultural programs was to enhance farm income by providing financial support to producers growing grains, oilseeds and more recently, specialty crops. By strengthening these crop sectors, support programs favoured cultivation over other land uses. In recent years, governments have moved to a 'whole farm' approach for income support programs. These more recent programs have little effect on land use decisions made by the agricultural sector. The adoption of environmentally-friendly agriculture policies could have an enormous impact on the long-term land use in the watershed.

Roadways, and to some extent railways, have altered the natural drainage patterns within the watershed. Roadway ditches are being used as waterways and their presence has encouraged drainage of adjacent wetlands.

A study by Ducks Unlimited Canada in 1995 found that for an area near Yorkton, the average loss of wetlands was 45 percent since the 1950s. A second study by Ducks Unlimited Canada in 1999 concluded that most of the change to wetlands had occurred prior to 1981 in the intensively drained areas, and that more recent efforts by landowners in these areas were focused on improving or maintaining existing drainage works.

A 1994 SaskWater study of a township near Langenburg found that in 1957, wetlands occupied 16 percent of the township, and bush and uncultivated areas occupied 42 percent. By 1989, wetland area had been reduced to seven percent and unimproved area had decreased to 14 percent.

Canadian Wildlife Service annual surveys indicate that most temporary wetlands are cultivated and the margins of semi-permanent and permanent sloughs are highly disturbed.

5.2.3 Land and water management practices are affecting fish habitat.

Fish habitat may be affected either directly or indirectly by a variety of land and water management practices. Water storage and diversion works, such as dams and water intakes, affect the availability of water for instream uses by aquatic organisms, including fish. Fish need adequate amounts of water at appropriate times of the year for spawning, rearing and overwinter survival. Overbank flooding in the spring is needed for successful spawning by species such as northern pike.

The preliminary analysis of current instream flow needs suggests that water is available for aquatic ecosystems and off-stream uses, but during periods of low flows there may be conflict. Instream flow requirements should be determined for all streams before water is fully allocated for off-stream uses.

Stream channelization removes critical habitat such as spawning riffles, instream cover and deep pools. This reduces habitat diversity, which in turn reduces the diversity and productivity of aquatic biota. Channelization and other physical disruptions of streams must be minimized to preserve adequate amounts of aquatic habitat. Where physical disruptions cannot be avoided, mitigation or compensation must be conducted to ensure no net loss of aquatic habitat.

Changes to the flow regime resulting from land use changes and wetland drainage affect aquatic habitat. These can be ameliorated to some degree by developing riparian buffers, limiting wetland drainage and re-establishing wetlands where practical. Conversion of treed land to cropland and drainage of sloughs increases the magnitude of flows.

Higher flows increase instream erosion, with the resulting sedimentation covering important stream habitat for fish and other aquatic life.

Dams, weirs and improperly constructed road crossings block fish migrations, disrupt the life cycle of fish, limit their range and reduce biodiversity.

5.2.4 Increased bank erosion of streams and rivers diminishes water quality. Increased erosion and sedimentation reduces fish spawning areas and habitat.

A considerable amount of natural bank erosion occurs along watercourses in the watershed each year. However, the loss of vegetation cover due to human influences can aggravate streambank erosion.

The practice of grazing cattle adjacent to waterways and allowing them free access to the stream destroys riparian cover and compromises bank stability.

Increased suspended solids resulting from erosion impairs the water quality for many consumptive purposes, resulting in more complex treatment processes and higher treatment costs.

Fish and other aquatic life are negatively affected by increased sedimentation and loss of shade provided by streambank vegetation. Fish spawning, nursery or feeding areas may be covered with sediments. Similar adverse impacts may affect other forms of aquatic life.

In past years, numerous riparian enhancement demonstration projects have been undertaken in other watersheds to repair streambanks and replace removed or eroded riparian vegetation. Experience has shown that a re-established riparian area can quickly return the stream to a more natural state.

Additional efforts are needed to move beyond demonstration projects and have landowners assume more direct responsibility for the maintenance of a healthy and effective riparian zone adjacent to streams and marshes. The prevention of erosion on private land would improve the sustainability of the owner's operation and reduce harmful environmental impacts.

5.2.5 Conflicts between land use for agriculture and wildlife habitat should be resolved to give better direction for water management.

Water and wildlife are Crown-owned natural resources. However, conflicts can arise between agriculture and conservation interests when these resources are located on private land.

Approaches are needed to bring these interests together to resolve conflicts in order to achieve their respective goals. Development of a practical conservation ethic is needed to make progress towards sustainable agricultural practices and sustainable natural ecosystems. The role of water in the natural environment should be properly valued by the agricultural industry and other users in the rural landscape.

Planning of wetland drainage should recognize the importance of retaining a complex of wetlands with a variety of wetland habitats on the landscape. Because of the variability in landscape conditions, and the surrounding habitat complex, it is very difficult to provide a simple description of which wetlands can be modified with the least environmental effects.

5.2.6 Oil and gas industry development is a threat to surface and groundwater in the watershed.

The Advisory Committee has expressed concerns with the oil and gas industry, which is new to the watershed. These recent activities are associated with several exploration activities now occurring in several parts of the watershed. Historically, there was previous oil and gas exploration, drilling and production activity near Kamsack.

There have been several incidents involving the oil and gas industry across North America that have been reported in the media. This has made most rural land owners very aware of the potential for source water contamination.

Hydrocarbons can have enormous long lasting impacts on aquifers. Once an aquifer is contaminated with hydrocarbons it is extremely difficult to mediate. The impacts on surface water affect water quality and all forms of life in both direct and direct association. The impact is usually highly visible. Surface water ecosystems can recover from relatively small oil incidents much faster than groundwater.

In both scenarios it does not take a high hydrocarbon volume to have a major impact on a large volume of source water. It is often quoted that ‘one litre of oil can contaminate up to 2 million litres of water’. There are concerns about all aspects of the oil and gas industry. Exploration, development, production, storage, transportation, and decommissioning all have potential impacts on source water.

Within Saskatchewan, the oil and gas industry is highly regulated. The Province wants the economic benefits of the oil and natural gas industry, while at the same time minimizing environmental impacts.

5.2.7 The development of regional waste management sites may be of concern to water quality.

This consideration has been moved and combined with item 4.

5.3 Water Quantity Related

5.3.1 Surface water supply may not be adequate to meet future water demand

Total annual surface water use in the watershed is approximately 53,000 dam^3 when wildlife conservation projects are included, representing approximately 13 percent and 17 percent of the mean annual and median annual natural runoff volumes for the watershed, respectively. This represents approximately 75 percent of the lowest annual volume on record (about 74,000 dam^3 in 1961). Apportionment is not an issue in the watershed at this time.

A mathematical water management model was constructed to examine the state of surface water supply and the major water uses on a mean monthly basis (Appendix B). The analysis revealed that, at both the current and future level of water use, surface water supply is generally sufficient, although somewhat less reliable in the headwaters of the watershed and subject to droughts.

A preliminary analysis of instream flow requirements suggests that water is generally available for aquatic ecosystems and offstream uses, but during periods of low flows there may be conflict with other water uses.

Detailed site-specific analysis of water availability and quality is still required when considering the potential to meet the water needs of individual projects. Some attempts are being made to show strictly physical water availability on a map using GIS technology.

Current products only show generalized water availability and ignore water quality and the variability of surface water supply. These applications are very general and cannot be applied to specific areas or uses. Such approaches may prove useful in the future, with better data and further refinement.

5.3.2 Groundwater demand could exceed the sustainable groundwater supply.

Public concern with overall aquifer management, including water use and aquifer protection, and aquifer recharge has been identified.

In the Yorkton area, groundwater demand is approaching the limit of the available supply from the aquifer. The Yorkton Aquifer System is large and has a significant number of users relying on it for water. An aquifer management plan is under way in the area.

Currently, there are no other large aquifers or aquifer systems in the watershed known to be under similar stress, but because of insufficient data this is not known for certain. However, there are a number of smaller aquifers which could be near their sustainable limit and may need some type of management plan in the future. The lack of basic technical data and/or resources necessary for aquifer management precludes a broad and comprehensive understanding of the watershed groundwater resource and its ability to provide water. Issues such as the sustainability of uses, artificial recharge, recharge areas, aquifer protection and, ultimately, supply must be examined.

5.3.3 The current and future ability to make good use of available water may be limited by the state or scale of the necessary infrastructure.

There are concerns that the water supply infrastructure in some communities within the watershed requires maintenance or updating.

The deteriorating condition of the Sturgis Weir is one example. There is general concern with the potential accelerating effect of drainage on siltation of water bodies. At Kamsack, the concern is about increased silt accumulation reducing the water quality and the available storage volume in the reservoir.

Interest in expanding infrastructure, such as water supply projects, also exists. While new infrastructure may be able to provide water of better quantity or quality, any concerns about the projects are likely with the economic and financial feasibility, rather than the technical feasibility of maintaining or improving infrastructure.

There is local interest in rural water distribution systems. Where there are areas of water shortages, poor water quality, or where individual water sources are costly, rural distribution systems from a central source are an option. For example, some First Nations are concerned about water quality in the Assiniboine River and are interested in alternate sources.

Communities may face very costly maintenance or upgrade costs, limitations on growth or complete loss of service. Inadequate infrastructure leads to uncertainty of water supply and thus inhibits economic growth.

5.4 Analysis of Current Watershed Management Issues/Considerations

The original Upper Assiniboine River Basin Study expended considerable efforts on identifying issues related to water. The UARB Study was more broadly focussed than this analysis, which is primarily focussed on issues more directly related to source water and the protection of source water.

As noted earlier, it was decided to organize the UARB "water quality" issues or concerns separate from "watershed health or wildlife" issues (if related to water quality) as an initial step. Other considerations or issues raised by the Advisory Committees were later added to the process.

The Technical Committee was then charged with analysing these issues further and preparing the analysis based on the following:

- Technical Committee members were to first review information and data contained within the UARB Study report to determine relevance and whether new information was required and/or updating the previous analysis.

In addition, the following points were to be considered when preparing the analysis:

- Whether any regulations apply to the issue, and under what circumstances.
- The agency(s) which (are) responsible for administering the regulations.
- Whether policies are also being utilized, and whether internal policy within the agency administering the regulations has any impact on how the regulations are enforced.
- Available research or data that demonstrates the relevance to source water protection.
- An inventory, if applicable (e.g. # of ILO's). An inventory may be available in a variety of forms. Obviously our ultimate goal is to have the data in a GIS-friendly format.

Several expert presenters were invited to attend Technical Committee meetings to inform the committee of their field of expertise as it applies to the issues and source water protection.

Another component of the issues analysis was considered very relevant by the Technical Committee; the aspect of potential risk to source water. Dr. Terry Hanley, Director of Watershed Monitoring and Assessment with the Saskatchewan Watershed Authority, led the Technical Committee through a risk assessment process. This process was utilized to help the committee clarify the issues analysis and to focus on the most relevant threats to source water by prioritizing or ranking the issues or stressors.

Dr Hanley provided a document which outlined a step-by-step procedure for reaching a final factor or score for each issue. It should be emphasized that this process was only one tool that was used to evaluate the severity of a risk to source water. There are several other methods, and this process should not be considered the sole methodology. Briefly, this process involved:

- An initial group discussion regarding the scope and scan of each issue, including a description of the stress, exposure, response relationships of the issue.
- Establishing whether the stress factor of the issue was increasing, decreasing or stable.
- Identifying the stressors involved in the issue.
- Determining exposure pathways.
- Defining whether the issue is significant.
- Assigning a risk severity score of minor, adverse, serious or critical in each of three categories: Health Criteria, Ecological Criteria, and Socio-Economic Criteria
- Then an extent of the risk was determined, for each of the categories

Based on the above, risk factor scores were calculated and a final score was assigned for each issue. The strategy behind this exercise was to have the planning process focus on those issues that were identified as having the highest potential risk to source water.

The details of the issues analysis will be included as an Appendix to the final Assiniboine River Source Water Protection Plan. Only those issues that scored highest were considered for this analysis, and objectives, recommendations and key actions were developed only for the highest scoring issues. The Technical Committee recognized that to analyze every issue would be very time consuming and that, once implementation of the source water protection plan is initiated, recommendations and key actions for the less relevant issues (from a source water protection perspective) would likely be changed.

Thus, objectives, recommendations and key actions will be developed to address the most relevant issues, and these will form the basis of the Assiniboine River Source Water Protection Plan.

6. Function of Landcover: Wetlands, Riparian Areas and Uplands

Wetlands, riparian buffers and uplands are vital components of watersheds and freshwater sustainability in Saskatchewan. These landcover components provide many functions that improve the quality of source waters while at the same time providing wildlife habitat.

6.1 Upland Habitat

Upland soil conservation programs, such as low disturbance direct seeding, no-till and permanent perennial cover decrease exposed soils under conventional tillage practices, and especially reduce summer fallow acres. Winter wheat has potential to be promoted as a program to retain stubble and decrease erosion. The enhanced land cover provides water quality benefits such as: reducing surface runoff velocities, trapping sediments and increasing infiltration, and reducing the amount of sediments, nutrients and pesticides that enter watercourses within the watershed.

The most beneficial outcome from implementing practices such as conservation tillage and permanent perennial cover is the reduction of soil erosion. Both wind and water (rainfall, snowmelt runoff) erosion occurrences are greatly reduced.

Increases in crop residues and perennial cover results in the following benefits for source water enhancement:

- Increased water infiltration
- Reduced soil erosion
- Increased soil organic matter

In addition, there are reductions in operating costs (labor and fuel savings), which is also environmentally friendly because of the reduction in Greenhouse Gas emissions.

Upland cover has been shown to be effective in reducing the amounts of nitrogen (up to 90 percent), phosphorus (up to 91 percent) and pesticides (up to 100 percent) in surface water runoff. There is potential for increased leaching through the soil profile to groundwater (Gabor et al., 2001) under certain situations. For the Assiniboine River Watershed, this occurrence would be relatively low since the soils of the watershed generally have a high clay silt content which has associated low water transmission rates. The soils also readily bind with phosphorous. Thus, if the incidence of soil erosion is kept in check, then phosphorous also remains on the uplands.

Conservation tillage does not always reduce nutrient and pesticide leaching. However, this practice is usually recommended because the benefits far outweigh the potential drawbacks. In soils susceptible to leaching, permanent cover is a better management practice. Land seeded to perennial cover results in fewer pesticides and fertilizer nutrients applied, and less subsequent movement to source waters.

Currently there is insufficient information regarding upland conservation practices and pathogen movement.

6.2 Riparian Habitat

Riparian areas are the transition zones between the uplands and wetlands, streams or lakes. Due to increased water availability, this zone is usually characterized by dense vegetation. Riparian areas/vegetative buffer strips can effectively control erosion by forming a physical barrier that slows the surface flow of sediment and debris.

Buffers function by decreasing the velocity of surface runoff, which results in the settling-out of suspended soil particles and enhances the infiltration of water born nutrients contained in the runoff within the buffer. Buffers also effectively trap fertilizers, pesticides, pathogens and heavy metals.

The required width of a buffer strip is determined by the type of vegetation present, the extent and impact of the adjacent land use, the slope of the uplands, the soils within the uplands and the functional value of the receiving aquatic habitat. However, several studies have found the bulk of sediment removal occurs in the first few metres of the buffer zone.

To maximize the benefits of buffers it is recommended that they are combined with other conservation tillage practices, such as zero till or low disturbance direct seeding. Since most of our runoff occurs in the spring, the practice of retaining stubble over winter on fields, at least those adjacent to waterways, would be advantageous.

The following table summarizes the benefits of buffers and the various vegetative treatments.

Table 8: Summary of Buffer Benefits

Benefit	**Vegetation Type**		
	Grass	**Shrub**	**Tree**
Stabilize bank erosion	low	high	high
Filter sediment	high	low	low
Filter nutrients, pesticides, microbes			
sediment bound	high	low	low
soluble	medium	low	medium
Aquatic habitat	low	medium	high
Wildlife habitat			
range/pasture/prairie wildlife	high	medium	low
forest wildlife	low	medium	high
Economic products	medium	low	medium
Visual diversity	low	medium	high
Flood protection	low	medium	high

In the Assiniboine River Watershed, the natural riparian habitat has been altered by various landscape activities such as industry, agriculture and urban development. In some parts of the watershed the riparian areas adjacent to the river has been removed or seriously degraded by cultivation or grazing. The removal of this vegetation results in increased sediment, pesticide and fertilizer residues reaching the river. It also destabilizes the banks, making them more prone to water erosion that may result in increased siltation in the river.

In general the main stem Assiniboine and larger tributaries have reasonable riparian habitat. The headwater reaches of some of the tributaries have more encroachment.

6.3 Wetland Habitat

The hydrological functions of wetlands may, to varying extents, include the storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows, de-synchronization of flood peaks, and erosion prevention. Position in the landscape, location of the water table, soil permeability, slope, and moisture conditions all influence the ability of wetlands to hold back floodwaters.

Wetland drainage reduces the capability of a watershed to hold back runoff during flood conditions. The UARB Study concluded that for major flood events, wetland drainage had a minor impact. Wetland storage was more relevant during minor to moderate runoff events.

Recharge of groundwater is an extremely important function of some wetlands. Water percolates slowly from wetlands to aquifers. Interactions between wetlands and local or regional groundwater supplies are complex, site-specific, and are affected by the position of the wetland with respect to groundwater flow systems, geologic characteristics of the substrate, and climate.

Wetlands are extremely complex systems. They retain nutrients in buried sediments, convert inorganic nutrients to organic biomass, and their shallow water depth maximizes water-soil contact and therefore maximizes the microbial processing of nutrients and other material in the overlying waters. Wetlands can be effective nitrate sinks in agricultural landscapes (over 80 percent removal). Phosphorus retention in wetlands can also be significant (up to 94 percent) and is accomplished through adsorption onto particles, precipitation with metals and incorporation into living biomass.

Wetlands can reduce the impacts of sedimentation on water quality within watersheds. Hydrology is a primary determinant of the sediment retention capacity of a wetland and determines the source, amount, and spatial and temporal distribution of sediment inputs. Percent of wetland area and position are important in reducing the sediment loads of the water passing through the system.

High levels of biological productivity in wetlands result in the removal of pesticides. This is due to the large quantities of submerged and emergent plant growth that increases the surface area for pesticide adsorption, plant sequestration, and microbial degradation.

Impact on Microorganisms

Many infectious diseases are transmitted via animal and human feces. Waterborne pathogens of serious risk to humans include strains of bacteria such as enteropathogenic *Escherichia coli*, *Salmonella typhi*, *Campylobacter spp*; viruses such as enteroviruses and Hepatitis A; and the protozoans such as *Entamoeba histolytica*, *Giardia intestinalis*, and *Cryptosporidium parvum*. These pathogens are persistent in water supplies due to their ability to survive outside of host organisms. Protozoa transform into cysts, and are able to survive harsh environmental conditions.

The ability of constructed wetlands to reduce populations of pathogenic micoorganisms in wastewater effluent has been demonstrated globally. Many of the processes that reduce pathogen populations in natural systems are equally or more effective in wetland treatment systems. Structurally and functionally, most wetlands are dominated by naturally occurring populations of microbes and plant life. Microbial populations in wetlands include the diverse flora of bacteria, fungi and algae that are important for nutrient cycling and biological processing. In addition, zooplankton grazers may be an important pathogen removal mechanism in wetlands during certain seasons.

Macrophytes are essential because they provide surface contact area for microbes that mediate most of the nutrient and pollutant transformations that occur in wetlands. Vegetated wetlands appear to be more effective for pathogen removal than facultative ponds and other natural treatment systems that have less physical contact between pathogens and solid surfaces. Treatment wetland removal efficiencies are nearly always greater than 90 percent for coliforms and greater than 80 percent for fecal streptococcus.

7. Current Watershed Management

There are many different tools available to assist in watershed management. These include municipal planning and zoning, various provincial regulations, and stewardship activities. While a number of provincial authorities have a stake in watershed management, the municipalities have significant authority to manage development and land use within the watershed.

7.1 Municipal Planning and Zoning

General Information

The foundation of the community planning process is a policy plan. *The Planning and Development Act* allows two types, a *Basic Planning Statement* and a *Development Plan.* A council may pass a bylaw to adopt one or the other, depending on the needs of the municipality.

A policy plan enables a municipality to set development goals, objectives and policies which council can use to manage land use, subdivision, municipal services, and public utilities in the municipality. Once adopted by a council, a policy plan outlines the municipality's land use and development objectives and policies, as well as future development patterns. It also identifies the tools the municipality will use to implement the plan and achieve the objectives, and provisions for the protection of the health, safety and welfare of the general public.

Without a policy plan, a municipality has little control over development and related servicing demands, and it cannot enforce the separation of incompatible land uses.

Basic Planning Statements

A basic planning statement contains short declarations of a council's objectives and policies for development in the municipality. It is usually suitable for urban and rural municipalities that are not experiencing large scale or numerous development proposals. This statement contains the objectives for the future development, objectives to be accomplished by a zoning bylaw, and incorporate any applicable provincial land use policies.

Development Plans

A development plan may be more complex and broader in scope than a basic planning statement. It is suitable for urban and rural municipalities examining numerous development proposals or complex development issues needing special zoning regulations. The development plan serves as a framework whereby the municipality may identify the critical problems and opportunities concerning the development of land and the social, environmental and economic effects of that development, and helps to establish and specify the programs and actions. It also provides for a capital works program necessary for the implementation of the development plan, and to outline the methods whereby the best use and development of land and other resources in adjacent municipalities, or affected areas immediately abutting thereto, may be coordinated.

Zoning Bylaw

The primary legal and administrative means of implementing a policy plan is a zoning bylaw. A zoning bylaw divides a municipality into zoning districts and regulates the development and use of land in those districts. A zoning bylaw permits a council to set standards for the use and subdivision of land, and helps manage the supply of municipal services and resources to new development.

The zoning bylaw therefore enables the municipality to manage land use through legislation, including the opportunity to regulate development adjacent to or in the vicinity of any water supply or source.

ASSINIBOINE RIVER WATERSHED

The following Table summarizes the current planning and zoning status for each of the Rural Municipalities within the Assiniboine River Watershed.

Table 9: Summary of RM Planning and Zoning Status

Name of RM	RM Number	Land Use Control Present	Basic Planning Statement	Zoning Bylaws
Spy Hill	#152	Y	Y	Y
Langenburg	#181	Y	Y	Y
Churchbridge	#211	Y	Y	Y
Saltcoats	#213	Y	Y	Y
Cana	#214	Y	N	Y
Stanley	#215	N	N	N
Calder	#241	N	N	N
Wallace	#243	N	N	N
Orkney	#244	N	N	N
Garry	#245	Y	Y	Y
Ituna Bon Accord	#246	N	N	N
Cote	#271	Y	N	Y
Sliding Hills	#273	N	N	N
Good Lake	#274	Y	N	Y
Insinger	#275	N	N	N
Foam Lake	#276	Y	Y	Y
St Philips	#301	N	N	N
Keys	#303	Y	Y	Y
Buchanan	#304	N	N	N
Invermay	#305	N	N	N
Clayton	#333	N	N	N
Preeceville	#334	Y	Y	Y
Hazel Dell	#335	N	N	N
Sasman	#336	Y	N	Y

It should be noted that there are at least 5 additional RM's considering adopting Basic Planning Statements and Zoning Bylaws.

At present there is only a single Planning District within the Assiniboine River Watershed: the Yorkton Regional Planning District, which involves portions of the City of Yorkton and portions of the RM of Wallace.

7.2 Legislation and Enforcement

The following federal and provincial policies, legislation, guidelines, and programs are relevant to how water and related resources are currently managed in the Assiniboine River Watershed.

Provincial

The Agricultural Operations Act

This Act, administered by Saskatchewan Agriculture, Food and Rural Revitalization, replaces the former *Pollution (by livestock) Control Act*. The Act provides protection from nuisance claims if an agricultural operation is functioning within normally accepted practices. An agricultural operations review board hears complaints from persons aggrieved by an agricultural operation. Subsequent to board proceedings, the board may dismiss a complaint, recommend a cease to the practice, or to modify a practice that is the subject of a complaint. The Act further sets out the terms and requirements for an approved plan for waste storage and management associated with an intensive livestock operation (ILO).

The Conservation and Development Act

This Act, administered by the Saskatchewan Watershed Authority, provides for the development of Conservation and Development Areas by ministerial order upon receipt of a petition signed by at least two-thirds of the landowners within a proposed area, or by discretion of the Minster. An area authority board has powers to assess benefited lands to pay local costs of administration, construction, operation and maintenance of works. Other powers include expropriation of lands, borrowing of money, and issue debentures. An area authority can promote, construct, operate and maintain flood control, drainage, and multi-purpose works for the benefit of agriculture lands and wildlife.

The Environmental Assessment Act

This legislation authorizes Saskatchewan Environment to review potential environmental effects of a proposed development. The Act lays out the process used to determine whether or not a project is a development and provides opportunities for public to influence government decisions about a project. Any project defined as a development must be approved by the Minister of Environment before it may proceed. A proponent is required to complete an environmental impact assessment (EIA) for any project proposal that is defined. The EIA is reviewed by a technical panel. The Minister may approve the project with or without conditions, or may not allow the development to proceed.

The Environmental Management and Protection Act (EMPA) 2002

This Act, administered by Saskatchewan Environment, governs pollution control in the province. The Act specifically deals with water pollution control, industrial effluent works, sewage works, waterworks, and regulations of all matters concerning water quality. A ministerial order can require the individual responsible for a pollutant discharge to take necessary measures to protect or restore the environment. Individuals, including the Crown, may seek compensation for damages incurred from a pollutant discharge, or for failure in the execution of a duty. The Act allows for permits to be provided for the discharge of contaminants which might cause a change in water quality or water pollution. It also allows the Minister to issue shoreline alteration permits for activities affecting the bed, bank or boundary of a water body and states which activities are deemed exempt from requiring a permit. These exemptions include excavation and replacement of culverts, directional boring, continued cultivation of intermittent water courses, removal of beaver dams by hand or dynamite, cutting, mowing, or haying under dry conditions but no harrowing, livestock grazing that does not result in exposed soil, stream bank slumping or erosion, burning between August 1 and April 30, crown timber harvesting under an approved plan, maintenance of utility lines, storm water and Conservation and Development Area ditches and road allowances. Exemptions may be limited with regards to the environmental conditions under which work is being carried out. Failure of a developer to obtain a permit constitutes an offence.

This Act also prevents the spraying of pesticides within 25 metres (50 metres if aerial application) of the high water mark on any surface waters or courses including intermittent waterways and drainage ditches without a permit.

The Ground Water Conservation Act

The purpose of this Act, administered by the Saskatchewan Watershed Authority, is to obtain logs of wells drilled and information on formations and materials encountered during drilling operations. This is to assist in groundwater and geological studies and to provide for the conservation, development, and utilization of groundwater resources and prevent pollution and contamination of groundwater. Groundwater approvals are issued under *The Saskatchewan Watershed Authority Act*.

The Irrigation Act, 1996

The Irrigation Act defines the responsibilities and roles of irrigation district boards, the Minister responsible and Saskatchewan Agriculture, Food and Rural Revitalization, which administers the Act. The Act also provides for the establishment of the Irrigation Crop Diversification Corporation, and provides for the administration of the Saskatchewan Irrigation Projects Association. It further establishes the requirement for an irrigation certificate (soil-water compatibility), district irrigation replacement funds, and the form of water services agreements prior to a person receiving irrigation services.

The Oil and Gas Conservation Regulations, 1985

This Act provides the requirements for oil and gas exploration and development. The Act clearly defines areas where the drilling of wells is prohibited without approval of the Minister. Surface casing, general plugging and abandonment requirements to protect groundwater contamination are also clearly defined.

The Planning and Development Act, 1983

In Saskatchewan, the primary responsibility for community planning, development issues, land use and municipal services rests with the local municipalities. To manage these interests, municipalities have the authority to carry out planning, establish zoning controls, require development permits, require servicing agreements and other such authorities to manage land use and development issues.

This Act establishes planning and land use authority in Saskatchewan. The Act prescribes two sets of regulations:

- *The Subdivision Regulations* are applied by the province unless superseded by a local subdivision bylaw or zoning bylaw regulation.
- *The Dedicated Lands Regulations* apply to the administration of lands known as environmental reserves, municipal reserves, public reserves, buffer strips, and certain walkways.

The Act provides municipalities significant governance to mange their community, municipal servicing, and development interests. Municipalities also have the ability to establish advisory planning districts and district commissions to assist them in joint management of land use and development interests. The commissions provide a formal process for inter-municipal discussions of mutual interest and create opportunity for consistent land use policies and zoning between the affiliated municipalities.

Saskatchewan Upstream Petroleum Industry Storage Standards (SEM Standards SO-01)

This document provides comprehensive storage standards for the upstream petroleum industry. The purpose of the storage standard is to ensure that the materials produced, generated and used by the upstream petroleum industry are stored in an environmentally responsible manner. Protection of groundwater and surface water was taken into consideration while drafting these standards.

Saskatchewan Watershed Authority Act

Established in October 2002, this Act establishes the Saskatchewan Watershed Authority, formerly the Saskatchewan Wetland Conservation Corporation. Its purpose is to manage and protect water, to promote economical and efficient use of water, to maintain and enhance the quality and availably of water, and to promote and coordinate management and administration, development conservation, protection and control of the water, watersheds and related land resources. A significant proportion of the former *The Water Corporations Act* was included in this new piece of legislation. This legislation sets out how a person or corporation establishes the procedure for obtaining licenses for ground and surface water. The Act also outlines procedures for obtaining a license for drainage works, and identifies that both the property as well as the right to use surface and groundwater belongs to the Crown.

The Seismic Exploration Regulations, 1999

This Act states that a preliminary plan must be approved by the Minister prior to any seismic exploration activities. The Minister may require the holder to notify local authorities and provide information on the contractor doing the work. Approval is also required if the shot hole is within a prescribed distance to a structure. Charges placed on the surface or more than 30 metres deep must also have approvals. This Act also defines the responsibilities of the individual if gas or water should be found during drilling. Any damages to land or structured caused by operations must be repaired at the holder's expense.

Shoreland Pollution Control Regulations 1996

http://www.gp.gov.sk.ca/documents/English/Regualtions/Regulations/SR54-76.pdf

The Watershed Associations Act

This Act, administered by the Saskatchewan Watershed Authority, allows for the establishment and alteration of Watershed Associations by Order in Council following the receipt of resolutions passed by local agencies on a voluntary basis, such as rural and urban municipalities, conservation and development area authorities, regional parks, resort villages etc. The governing Board is appointed from representatives from each agency. The Board has powers to assess levies to each agency to cover administration costs, and costs of construction, operation, and maintenance of works. Boards have expropriation powers and may undertake construction, replacement, or maintenance of a public work if the utility is not excising its powers. Boards can plan, undertake, construct, alter, improve, maintain, repair and operate projects for the purpose of storing, conserving, protecting, or developing the water resources available. In addition, it may conserve, control, protect, and develop land, forests, recreational resources, and fish/wildlife habitat.

Saskatchewan Plumbing and Regulations Act

These regulations are currently being updated.

Federal

Canadian Environmental Assessment Act

The Canadian Environmental Assessment Agency (CEAA) is responsible for coordinating federal environmental assessments under the *Canadian Environmental Assessment Act.*

The CEAA came into force in January 1995. The CEAA and its regulations are the legislative basis for the federal practice of environmental assessment. The legislation ensures that the environmental effects of projects involving the federal government are carefully considered early in the project's planning stages. Many assessments are conducted jointly with the provinces.

The Act sets out responsibilities and procedures for the environmental assessment of projects involving the federal government. The Act establishes a clear and balanced process that brings a degree of certainty to the environmental assessment process and helps responsible authorities determine the environmental effects of projects early in their planning stage. The Act applies to projects for which the federal government holds decision-making authority, whether as proponent, land administrator, source of funding, or regulator.

For more details about *The Canadian Environmental Assessment Act* and Regulations go to http://www.ceaa.gc.ca/0011/act_e.htm.

Canadian Environmental Protection Act, 1999

The goal of the renewed *Canadian Environmental Protection Act*, 1999 (CEPA 1999) is to contribute to sustainable development through pollution prevention and to protect the environment, human life and health from the risks associated with toxic substances. CEPA 1999 also recognises the contribution of pollution prevention and the management and control of toxic substances and hazardous waste to reducing threats to Canada's ecosystems and biological diversity. It acknowledges for the first time the need to virtually eliminate the most persistent toxic substances that remain in the environment for extended periods of time before breaking down, and bioaccumulative toxic substances that accumulate within living organisms. Health Canada works in partnership with Environment Canada to assess potentially toxic substances and to develop regulations to control toxic substances.

The CEPA Environmental Registry is a comprehensive source of public information relating to activities under *The Canadian Environmental Protection Act*, 1999. In addition to providing up-to-date copies of current CEPA instruments, the primary objective of the Environmental Registry is to encourage and support public participation in environmental decision-making, by facilitating access to documents arising from the administration of the Act.

For details on CEPA 1999 visit Environment Canada's CEPA Registry Web site http://www.ec.gc.ca/CEPARegistry/regulations.

Canada Water Act

The Canada Water Act, proclaimed on September 30, 1970, provides the framework for joint federal-provincial management of Canada's water resources, including research and the planning and implementation of programs relating to the conservation, development and utilization of water resources.

Part I of the Act provides for the establishment of federal-provincial consultative arrangements for water resource matters and for cooperative agreements with the provinces to develop and implement plans for the management of water resources. The Act enables the Minister of Environment, either directly or in cooperation with any provincial government, institution, or person, to conduct research, collect data, and establish inventories associated with water resources.

Part II permits the joint establishment and use of federal or provincial incorporated agencies to plan and implement approved water quality management programs, where water quality has become a matter of urgent national concern. The provisions of this part have never been used.

Part III, which provides for regulating the concentration of nutrients in cleaning agents and water conditioners, was incorporated into *The Canadian Environmental Protection Act* (CEPA) by a proclamation on June 30, 1988.

Part IV provides for inspection and enforcement, allows the Minister to establish advisory committees, and permits the Minister, either directly or in cooperation with any government, institution, or person, to undertake public information programs. For more information: http://www.ec.gc.ca/water/en/info/pubs/ar/e_ar98-99.htm

Canada Wildlife Act

The Canada Wildlife Act, administered by Environment Canada, applies to a species that is wild by nature and the habitat of any such animal, plant or other organism. The Minister may designate an area as a wildlife area. Within such area, no person shall damage, destroy, remove a plant, or destroy or molest animals, nests, or eggs, without a permit issued by the Minister. There is one national wildlife area located along the Thunder Creek.

Fisheries Act

The Department of Fisheries and Oceans Canada is responsible for administering *The Fisheries Act* which prevents obstruction to fish passage and provides for the regulation of fishing, managing of fish stocks, fish habitat protection and pollution measures. Ministerial approval is required for any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat. Section 36 of this Act is administered by Environment Canada. It states that it is unlawful to add any deleterious substance to water frequented by fish. "Deleterious Substance" means:

- any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered harmful to fish or fish habitat or to the use by man of fish that frequent that water, or
- any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered harmful to fish or fish habitat or to the use by man of fish that frequent that water, and without limiting the generality of the foregoing includes
- any substances or class of substances prescribed pursuant to paragraph (2) (a),
- any water that contains any substance or class of substances in a quantity or concentration that is equal to or in excess of a quantity or concentration prescribed in respect of that substance or class of substances pursuant to paragraph (2) (b), and
- any water that has been subjected to a treatment, process or change prescribed pursuant to paragraph (2) (c).

Species at Risk Act (2002)

The purposes of *The Species at Risk Act* (SARA) is to prevent Canadian indigenous species, subspecies and distinct populations of wildlife from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and to encourage the management of other species to prevent them from becoming at risk.

This enactment establishes the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as an independent body of experts responsible for assessing and identifying species at risk. It provides that COSEWIC's assessments are to be reported to the Minister of the Environment and to the Canadian Endangered Species Conservation Council, and it authorizes the Governor in Council to establish by regulation the official list of species at risk based on that process.

The Act requires that the best available knowledge be used to define long- and short-term objectives in a recovery strategy for endangered and threatened species, and it provides for action plans to identify specific actions. It creates prohibitions to protect listed threatened and endangered species and their critical habitat. SARA creates a public registry to assist in making documents under the Act more accessible to the public, and it is consistent with Aboriginal and treaty rights and respects the authority of other federal ministers and provincial governments.

For more details, visit the Government of Canada web site at http://www.sararegistry.gc.ca/the_act/HTML/Part1_e.cfm.

Navigable Waters Protection Act

Transport Canada is responsible for administering this Act which ensures that navigable waters remain open to navigation. The Act requires that any works that substantially interfere with navigation be approved by the Minister. Any vessel that obstructs or endangers a navigable water is to be reported to the Minster or to the chief officers of customs and excised. The Act also prohibits the deposition of wood products, earth material or rubbish into the waters. This Act will have implications to the developments on and around the Assiniboine River. This act was formerly administered by the Department of Fisheries and Oceans Canada.

8. Glossary of Terms

Aerobic – living or taking place only in the presence of oxygen.

Allocation – the amount of water assigned for use, out of the total amount that is available for use in a particular watershed or aquifer.

Anaerobic – living or taking place in the absence of oxygen.

Aquatic – consisting of, relating to or being in water; living or growing in, on or near water.

Aquifer – A geological unit which can yield water to a well in usable amounts.

Base of Groundwater Exploration – A feature known as the base of groundwater exploration was established for the initial provincial groundwater maps and is shown on the cross section. Below the base of exploration, useable groundwater is either not present or is at too great of a depth to warrant drilling for small users.

Bedrock formations – Rock deposited prior to the glaciation. These layers are overlain by glacial deposits which consist of glacial till, sand and gravel.

Biodiversity – (Biological diversity) the many and varied species of life forms on earth, including plants, animals, micro-organisms, the genes they possess and their habitats.

Climate – meteorological elements (eg: precipitation, temperature, radiation, wind, cloudiness) that characterize the average and extreme conditions of the atmosphere over long periods of time at a location or region of the earth's surface.

Climate change – an alteration in measured meteorological conditions that significantly differ from previous conditions and are seen to endure, bringing about corresponding changes in ecosystems and socio-economic activities.

Conservation – the preservation and renewal, when possible, of human and natural resources. The use, protection and improvement of natural resources according to principles that ensure their highest economic and social benefits.

Conservation easement – a voluntary legal agreement between a property owner and a government or qualified conservation agency. These agreements are tailored to each individual landowner and conserve the property's natural values and features by restricting the type and amount of development that can occur on the owner's property.

Development – building, engineering, mining or other operations that alter or intensify the use of a resource.

Deleterious substance – any substance that is deleterious to fish, fish habitat, or to the use by man of fish that frequent that water. See *The Fisheries Act* for further details.

Discharge – the flow of surface water in a stream or ditch or the flow of groundwater from a spring or flowing artesian well; the rate of flow.

Diversion – the removal of water from any waterbody, watercourse or aquifer (either for use or storage), and includes the removal of water for drainage purposes. Construction of any works required for the diversion of water need approval pursuant to section 50 of *the Saskatchewan Watershed Authority Act*. The total diversion is equal to the allocation plus any losses from evaporation or seepage.

Drainage – movement of water off land, either naturally or man-made.

Drought - generally in reference to periods of less than average or normal precipitation over a set time, sufficiently prolonged to cause serious hydrological imbalance that result in biological or economic losses.

DUC – Ducks Unlimited Canada, an entity that conserves, restores and manages wetlands and associated habitat for North American waterfowl. These habitats also benefit other wildlife and people.

Ecological – pertains to the relationship between living organisms and their environments.

Economic development – the process of using and converting resources into wealth, jobs and an enhanced quality of life.

Ecosystem – the total community of organisms (biota), including humans, and their physical environment (abiota), that interact as a functional unit in nature.

Effective drainage area – the area which is estimated to contribute runoff in at least half of the years.

Effluent –wastewater discharged into the environment.

Facultative –. a qualifying adjective that indicates an organism can grow both with and without an environmental factor. For example a facultative anaerobe can either live in an aerobic environment or under anaerobic conditions. *First Nation* – an Indian band or an Indian community functioning as a band but not having official band status, not including Inuit or Metis peoples.

Grazing management – activities that ensure stocking rates are appropriate to sustain long-term health of livestock grazing conditions during wet and dry seasons.

Gross drainage area – The area bounded by the height of land between adjacent watersheds.

Groundwater – subsurface water usually in aquifers; water that occurs in voids or crevices of rock and soil.

Habitat – natural surroundings or native environment where a plant or animal grows and lives.

Headwater – small streams and lakes that are the sources of a river, located in the upper reaches of a watershed.

Hydro – from Greek hydor, meaning "water."

Hydrogeology – the science of subsurface waters and related geologic aspects.

Hydrology – the science of the waters of the earth, their occurrences, circulation and distribution on or below the earth's surface.

Intensive Livestock Operation (ILO) - production facilities such as feedlots and buildings where many animals are raised in a confined space that does not have naturally-growing vegetation and where waste accumulates if not removed (as defined by *The Agricultural Operations Act* in Saskatchewan).

Land cover – predominant vegetation on the surface of a parcel of land.

Land use – present use of a given area of land.

Leachate – a liquid that has percolated through or out of another substance such as soil or refuse, and may contain nutrients or contaminants.

Lithology – the characteristics of rock formations

Median – a value in a sorted (how is it sorted) range of values by which there are the same number of values greater than the median as there are smaller than the median. A statistical term used in non parametric statistics.

Native prairie – age-old plant communities of the prairie and parkland regions that may contain more than 200 types of grasses, flowers and shrubs (native grassland and parkland aquatic and terrestrial habitats)

Non-point source pollution – single or multiple contaminants of diffuse (source may be known) origin that enter waterways, degrading water quality.

Partnership – co-operative, collaborative alliance between/among stakeholders in a non-legal arrangement used to improve and build relationships and achieve common goals.

Permeability– the rate or flow of a liquid or a gas through a porous material such as soil or rock.

Point source contamination – a static and easily identifiable source of air, soil or water pollution.

Riparian – an area of land adjacent to or connected with a stream, river, lake or wetland that contains vegetation that is distinctly different from vegetation of adjacent upland areas.

Riparian areas – the zone of vegetation alongside waterways and other surface water. Lush and diverse vegetation is the best sign of healthy, well-managed riparian areas and is critical to filtering and slowing runoff.

River basin – an area that contributes to form a watershed. (See watershed)

Sewage – the waste and wastewater from residential or commercial establishments that are normally discharged into sewers.

Sewage lagoon – a shallow pond where sunlight, bacterial action and oxygen interact to purify wastewater; also used for storage of wastewater.

Source water protection – the prevention of pollution and the sound management of factors and activities that (may) threaten water quality and quantity of lakes, reservoirs, rivers, streams and groundwater.

Stakeholder – individual or group with direct or indirect interest in issues or situations, usually involved in understanding and helping resolve or improve their situations.

Stewardship – judicious care and responsibility by individuals or institutions for reducing their impacts on the natural environment.

Water quality – the chemical, physical and biological characteristics of water with respect to its suitability for a specific use.

Watershed – an elevated boundary contained by its drainage divide and subject to surface and subsurface drainage under gravity to the ocean or interior lakes.

Watershed health – the desired maintenance over time of biological diversity, biotic integrity and ecological processes of a watershed.

Watershed and aquifer management – a process, within the geographic confines of a watershed or aquifer, that facilitates planning, directing, monitoring and evaluating activities to ensure sustainable, reliable, safe and clean water supplies.

Watershed and aquifer planning – A process, within the geographic confines of a watershed or aquifer and with the participation of stakeholders, to develop plans to manage and protect water resources.
Wetland – an area of low-lying land covered by water often enough to support aquatic plants and wildlife for part of the life cycle. The wetland area includes the wet basin and adjacent upland.

9. Glossary of Units

Length					
1.0 m	=	1.0 metre	1.0 km	=	1.0 kilometre
	=	3.28 feet		=	1,000 metres
	=	39.37 inches		=	0.621 miles
Area					
1.0 m^2	=	1.0 square metre	1.0 km^2	=	1.0 square kilometre
	=	10.76 square feet		=	1.0 X 10^6 square metres
				=	0.386 square miles
				=	247 acres
				=	100 hectares
Volume					
1.0 m^3	=	1.0 cubic metre	1.0 dam^3	=	1.0 cubic decametre
	=	35.31 cubic feet		=	1,000 cubic metres
	=	220.083 imperial gallons		=	220,083 imperial gallons
	=	1,000 litres		=	0.810 acre feet
1.0 ig	=	1.0 imperial gallon	1.0 l	=	1.0 litre
	=	4.54 litres		=	0.221 imperial gallons
	=	0.00454 cubic metres		=	0.264 US gallons
	=	0.1605 cubic feet		=	0.001 cubic metres
				=	0.035 cubic feet
Rate					
1.0 igpm	=	1.0 imperial gallon per minute	1.0 lps	=	1.0 litre per second
	=	0.833 US gallons per minute		=	13.22 imperial gallons per minute
	=	0.076 litres per second		=	11.01 US gallons per minute
	=	6.54 m^3/day		=	8.640 m^3/day
	=	1.94 acre feet/year		=	31.54 dam^3/year
	=	2.39 dam^3/year			
1.0 m^3/day	=	1.0 cubic metre per day	1.0 dam^3/day	=	1.0 cubic decametre per day
	=	220 imperial gallons per day		=	1,000 cubic metres per day
	=	0.0116 litres per second		=	35.314 cubic feet per day
	=	35.32 cubic feet per day			

Table based on Beckie Hydrogeologists (1990) Ltd.

10. References

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Appendix A Assiniboine River Watershed Technical Committee Members

Member	Representing
Brad Ashdown	Saskatchewan Watershed Authority
Doug Brook	Ducks Unlimited Canada
Mike Buchholzer	City of Yorkton
Brian Campbell	Saskatchewan Agriculture and Food
Tim Cheesman	Saskatchewan Government Relations
John-Mark Davies	Saskatchewan Watershed Authority
John Fahlman	Saskatchewan Watershed Authority
Jon Gaudrey	Sunrise Health District
Rob Kirkness	Saskatchewan Watershed Authority
Neil Lamberty	Prairie Farm Rehabilitation Administration
Darlene McLeod	Saskatchewan Government Relations
Rick Orr	Fisheries and Oceans Canada
Jason Puckett	Saskatchewan Watershed Authority
Jim Rodgers, Ross Herrington	Environment Canada
Warren Thomson	Saskatchewan Watershed Authority
Rob Walcer	Saskatchewan Watershed Authority
Joe Zarowny	Saskatchewan Environment

Appendix B Fish Species of the Upper Assiniboine River Basin

Scientific Name	Common Name	Abbreviation
Ambloplites rupestris	rock bass	RCBS
Ameiurus nebulosis	brown bullhead	BRBL
Catostomus commersoni	white sucker	WHSC
Carpiodes cyprinus	quillback	QUIL
Culaea inconstans	brook stickleback	BRST
Cyprinus carpio	common carp	CMCR
Esox lucius	northern pike	NRPK
Etheostoma exile	Iowa darter	IWDR
Etheostoma nigrum	johnny darter	JHDR
Hiodon tergisus	mooneye	MOON
Hybognathus hankinsoni	brassy minnow	BRMN
Ichthyomyzon castaneus	chestnut lamprey	CHLM
Lota lota	burbot	BURB
Luxilus cornutus	common shiner	CMSH
Margariscus margarita	pearl dace	PRDC
Moxostoma anisurum	silver redhorse	SLRD
Moxostoma macrolepidotum	shorthead redhorse	SHRD
Notropis atherinoides	emerald shiner	EMSH
Notropis dorsalis	bigmouth shiner	BGSH
Notropis heterolepis	blacknose shiner	BLSH
Notropis hudsonius	spottail shiner	SPSH
Notropis stramineus	sand shiner	SNSH
Noturus flavus	stonecat	STON
Perca flavescens	yellow perch	YLPR
Percina maculata	blackside darter	BLDR
Percopsis omiscomaycus	trout-perch	TRPR
Pimephales promelas	fathead minnow	FTMN
Pungitius pungitius	ninespine stickleback	NNST
Rhinichthys atratulus	blacknose dace	BLDC
Rhinichthys cataractae	longnose dace	LNDC
Semotilus atromaculatus	creek chub	CRCH
Stizestedion vitreum	walleye	WALL

Data sources:
McCulloch. B.R. and W.G. Franzin. 1996. Fishes of the Canadian portion of the Assiniboine River drainage. Can. Tech. Rep. Fish . Aquat. Sci. 2087:v + 62 p
Sentar Consultants Ltd. 1996. Inventory of fish occurrences and morphological characteristics of streams in the Assiniboine River drainage basin in Saskatchewan. Prepared for Dept. Fisheries and Oceans Canada.
SERM file information

(Note: Only native species and introduced species that have established self-sustaining populations are listed. Exotic species that rely on stocking to maintain a population are not included).

Appendix C Water Quality and Water Quality Trends for the Assiniboine River at Kamsack

Summary

Water quality on the Assiniboine River at Kamsack, as evaluated by the Water Quality Index, was deemed to be of consistently fair to good quality between 1989 and 2004. The water quality index (WQI) objectives most often exceeded were total phosphorus, total dissolved solids (TDS), and to a lesser extent dissolved oxygen. A pronounced seasonality was observed for many parameters. For example, TDS typically exceeded water quality objectives during winter months, but rarely during spring runoff. Of the occasions when dissolved oxygen did not meet its water quality objective, the greatest proportion of these occurred during winter months. However, on several occasions dissolved oxygen was found not to meet its objective during the middle of summer.

Concentrations of dissolved inorganic nitrogen and total dissolved phosphorus were high, suggesting plankton were not nutrient limited. This conclusion of non-nutrient limiting conditions of the plankton community is similar to that made by Fortin and Gurney (1997) in their study of Lake of the Prairies. Nutrient concerns in rivers often focus on periphyton and macrophyte communities as opposed to plankton communities; however, there are no known data on the Assiniboine River system with which to evaluate nutrient-periphyton/macrophyte relationships.

Introduction

The Upper Assiniboine River basin is approximately 21 000 km^2. The headwaters of the Upper Assiniboine River are northwest of Preeceville in the Porcupine Hills, approximately 150 km northwest of its inlet to Lake of the Prairies. The major Saskatchewan tributary is the Whitesand River, which joins the Assiniboine River at Kamsack. The Assiniboine River eventually joins the Red River in Winnipeg, flows into Lake Winnipeg, and joins the Nelson River system that drains into Hudson Bay. A significant portion of the Upper Assiniboine River land catchment is agricultural.

This report summarizes water quality and water quality trends at a single sampling site (Kamsack) on the Assiniboine River. Water quality was evaluated with the Water Quality Index (WQI). Key water quality parameters were also evaluated for trends.

Methods

Site:

Water quality parameters evaluated in this report were sampled and analyzed by the Prairie Provinces Water Board (PPWB) near Kamsack SK (Station Number: SA05MD0002, 51°31'59" N 101°53'20" W). The sampling site is located at the bridge on highway 8, approximately 2 km south of Kamsack. During summer samples are collected from the downstream side of bridge, in winter samples are collected approximately 20 m upstream of the bridge (water depth is greater). The earliest available data was from 1968, although routine monthly sampling did not occur until around 1974. Due to possible changes in laboratory procedures and the number of parameters measured, the water quality index was evaluated from 1989-2004. Trend analyses were also evaluated from 1989-2004, because it is less likely that significant monotonic trends will be detected in longer data sets.

Daily hydrometric flow data was obtained from the Water Survey of Canada (2005), Station ID: 05MD004 51°33'53" N 101°54'58" W.

Water Quality Index

The WQI was used to assess the overall water quality at Kamsack on the Assiniboine River. When available, up to seventeen water quality parameters were included in the index. For each parameter the objective established by Saskatchewan Environment and the Saskatchewan Watershed Authority was used as the basis for assessing overall water quality (Appendix 1).

On each sampling date, the WQI evaluates the value of each water quality parameter relative to its objective value. The index is calculated by assessing 1) "Scope", the number of parameters that exceed their objective at least once in a year, 2) "Frequency", the number of times a parameter exceeds its objective in a year, and 3) "Amplitude", the amount by which the objective value is exceeded.

WQI values range from 100 (excellent) to 0 (very poor). WQI scores were grouped into one of five categories that serve to summarize the overall state of water quality. The categories and category descriptions are as follows:

> **Excellent:** (WQI value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels.
>
> **Good:** (WQI value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
>
> **Fair:** (WQI value 60-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
>
> **Marginal:** (WQI value 45-59) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
>
> **Poor:** (WQI value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

At least five different sampling dates per year were used to calculate the WQI for that year, with most years having 12 dates (monthly sampling).

The WQI calculator used was obtained from the Canadian Council of Ministers of the Environment (CCME 2005) and modified based on water quality parameters and their objectives set by Saskatchewan Environment and the Saskatchewan Watersned Authority (Appendix 1).

Trend Analysis

Nonparametric Mann-Kendall or Seasonal Kendall analyses were used to assess whether there were statistically significant increasing or decreasing trends in water quality parameters over time. Trend analyses were conducted using the computer program WQStat Plus (V.1.56).

Results

Flow

River flow characteristics are closely linked with water quality and river habitats. The Assiniboine is a perennial flashy river (Poff 1996) and is variable both within and among years. There were no apparent long-term increasing or decreasing trends in flow, although flow increased for several years in the mid 1990's (Figure 1a). Although the timing of the spring runoff peak is fairly consistent, its magnitude, and the magnitude of annual wintertime flow and late summer/early autumn low flow periods is variable among years (Figure 1b).

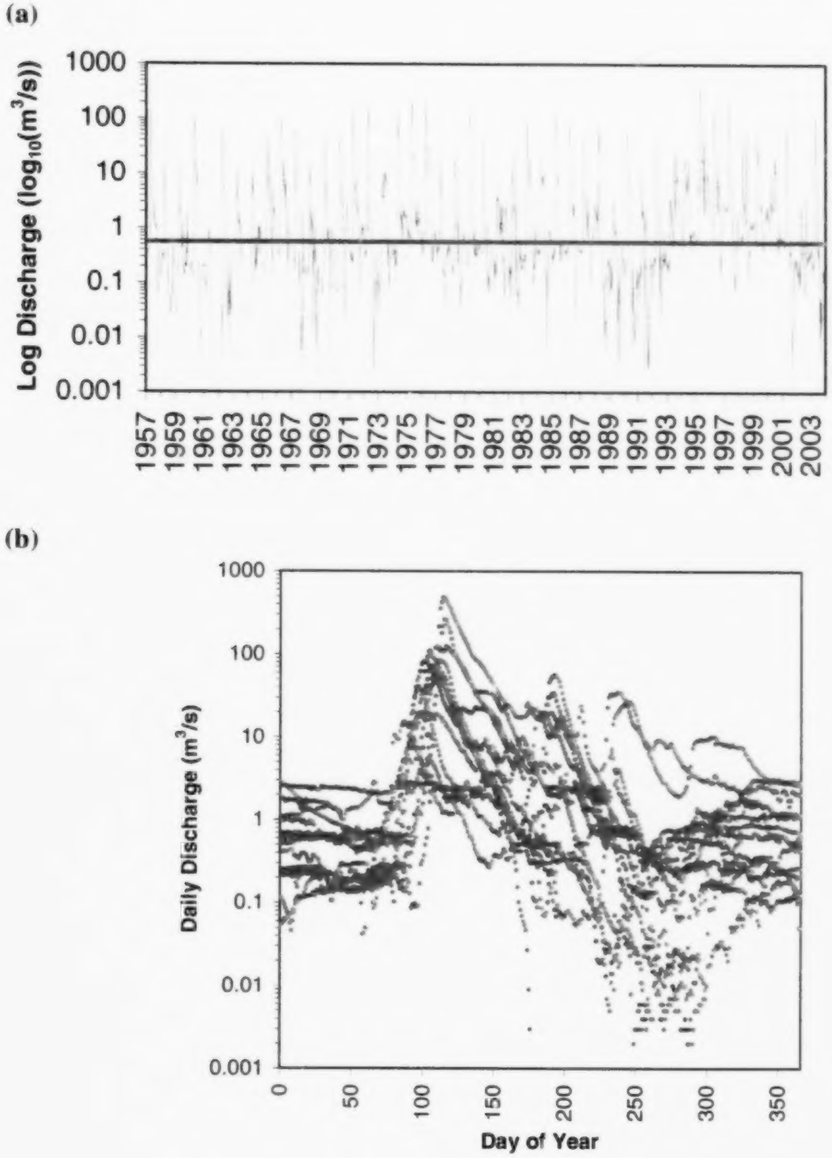

Figure 1: Average daily discharge on the Assiniboine River at Kamsack; (a) trends from 1957 to 2003, and (b) discharge for each day of the year between 1989 and 2003. Note log scales in (a) and (b). The horizontal line in (a) is the median discharge (0.56 m^3/s) from 1957 to 2003 (mean annual discharge = 5.68 m^3/s). Although there is an annual pattern in discharge, for example with a peak around April (approx. day of year 90–120), there is considerable variation in absolute discharge, discharge at high and low flow periods and the timing of secondary/tertiary peak flows. The maximum recorded discharge from 1957 to 2003 was 484 m^3/s in 1995.

Water Quality Index

The Assiniboine River at Kamsack is generally classified as having 'Good' to 'Fair' water quality (Figure 2). Total phosphorus often exceeded its objective, total dissolved solids (TDS) frequently exceeded its objective, and oxygen sometimes did not meet its objective. Other parameters either met or infrequently exceeded their objective.

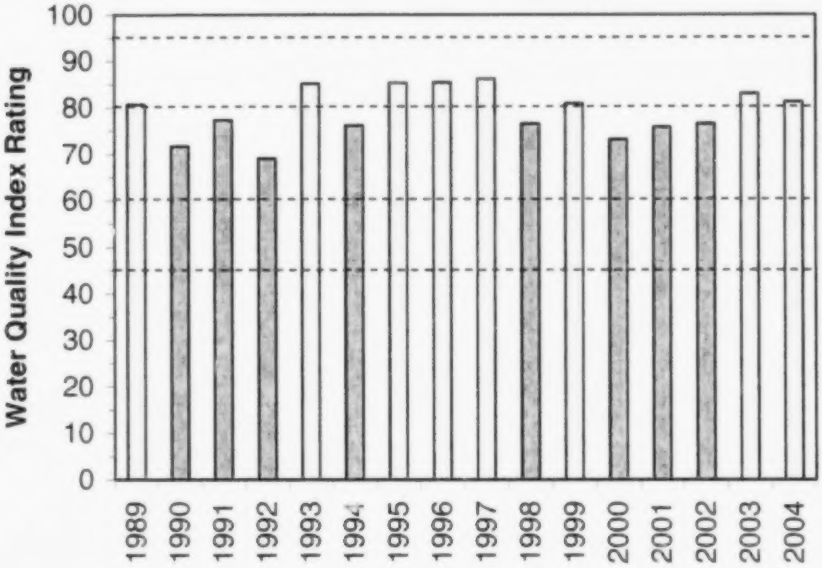

Figure 2: Water quality index rating for watershed protection at Kamsack on the Assiniboine River. Dashed lines correspond to WQI ratings (95-100 = 'Excellent', 80-95 = 'good', 60-80 = 'fair', 45-60 = 'marginal', less than 45 = poor.

Trend Analysis

Only pH, which increased, demonstrated a significant trend between 1989 and 2004 (Table 1). The measured maximum pH did not appear to increase between 1989 and 2004. However, the lowest measured pH seemed to increase. This increase in the lowest measured pH may be responsible for the significant increase in pH between 1989 and 2004 (Appendix 2-9). Trend analysis suggests a significant decrease in both 2,4-D and MCPA; however, a decrease in the detection limit over the period of study is responsible for this apparent trend (Appendix 2-11 and Appendix 2-12).

Table 1: Summary of trends for twelve water quality parameters at Kamsack on the Assiniboine River (1989 – 2003). Significant decreasing trends (↓), significant increasing trends (↑), and no significant trend (ns). No results are reported for 2,4-D and MCPA because of insufficient data, and/or too many values below the method detection limit.

	Kamsack
Dissolved Chloride (Cl^-)	ns
Dissolved Sodium (Na^+)	ns
Sulphate	ns
Total Dissolved Solids	ns
Total Phosphorus	ns
Nitrate/Nitrite	ns
Ammonia/Ammonium	ns
Dissolved Oxygen	ns
pH	↑
2,4-D	*
MCPA	*
Fecal coliforms	ns

* 2,4-D and MCPA measurements were often reported at the detection limit; however, the detection limit changed over time. Although the trend analyses suggest significant decreasing trends, these apparent trends are confounded by the change in detection limits.

Seasonal Cycles

There is an annual pattern in several water quality parameters, notably nutrients, alkalinity, conductivity, total dissolved solids, and turbidity (Appendix 3). Total nitrogen concentrations were typically greatest prior to, and during the beginning of spring runoff, whereas the greatest total phosphorus concentrations were observed either approximately a month prior to peak spring runoff, or around November (Appendix 3-1). Like total nitrogen, average nitrate and ammonia concentrations were greater during winter and early spring. The annual pattern in concentrations of total dissolved phosphorus is not distinct; however, peak concentrations more frequently occurred in the spring, summer and autumn (Appendix 3-2).

Measures of alkalinity, conductivity and total dissolved solids (TDS) all demonstrated a strong annual pattern (Appendix 3-3). All of these parameters were greatest during late autumn to late winter, they reached minimum values during spring run-off, and slowly increased during the summer. TDS is one of the parameters in the water quality index, so during winter months TDS is more likely to exceed its guideline (Appendix 3-3c). Turbidity, unlike alkalinity, conductivity and TDS, was greatest during spring run-off (Appendix 3-3d).

References

CCME (Canadian Council of Ministers of the Environment) 2005. Water, Water Quality Index, Index Calculator (Excel). http://www.ccme.ca/initiatives/water.html (accessed 7 April 2005).

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Appendix 1: WQI parameters, WQI objective values and trend analysis computations.

WQI parameters and objective values.

Category	Water Quality Parameter	Non-compliance objective
General		
	pH	< 6.5 or > 8.5
	Dissolved Oxygen (DO)	< 5.0 mg/L
	Chlorophyll *a* (Chl *a*)	> 50 ug/L
Dissolved Solids and Major Ions		
	Total Dissolved Solids (TDS)	> 700 mg/L
	Dissolved Sodium (Na^+)	> 100 mg/L
	Dissolved Chloride (Cl^-)	> 100 mg/L
	Sulphate (SO_4^{2-})	> 500 mg/L
Nutrients		
	Total Phosphorus (TP)	> 0.1 mg/L
	Nitrate/Nitrite (NO_3^-/NO_2^-)	> 1.0 mg/L
	Total Ammonia Nitrogen (NH_3)	pH and temp. dependent[¥]
Heavy Metals		
	Total Arsenic	> 50 ug/L
	Total Aluminium	> .5 mg/L
	Total Chromium	> 20 ug/L
	Total Mercury	> 0.1 ug/L
Pesticides		
	2'4-D[¤]	> 4 ug/L
	MCPA[§]	> 25 ug/L
Microbiological		
	Fecal Coliforms	> 1000 cfu[*]/100 mL

[¥] The objective value for total ammonia nitrogen varies with temperature and pH. When temperature is less than 30°C and pH is less than 9, the objective concentration of un-ionized ammonia is less than 33 μg/L.

[¤] 2,4-Dichlorophenoxyacetic Acid.

[§] MCPA, dimethylamine salt.

[*] Colony forming unit.

Trend-analysis summary plots

There are two plots for each parameter analyzed. The first is a Time Series plot, which shows all available data. Lines are drawn between points based on chronology. The second is the Trend Analysis plot. Where possible the compliance objective is shown on these figures as a dashed horizontal line.

Previous studies have demonstrated that the Mann-Kendall and Seasonal Kendall are susceptible to serially correlated data. If data were found to be significantly serially correlated, data were collapsed to seasonal (March-May, June-August, September-November, and December-February), or biannual (May-October, November-April) averages based on the presence of serial correlation. If there was significant seasonality, then analysis was conducted using the Seasonal Kendall, otherwise analysis was conducted using the Mann-Kendall.

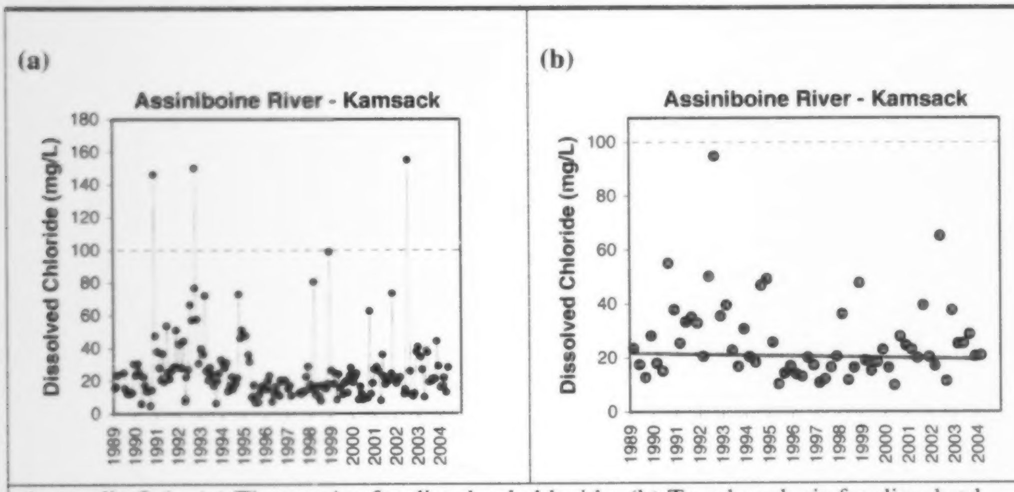
The steps taken for each parameter (i.e. data handling) are summarized in its figure caption. If there was no need to collapse data than trend analysis was conducted on individual measurements. If it was necessary to collapse the data, the figure legend notes whether data was collapsed to seasonal (4 seasons per year), or biannual means (2 seasons per year).

The seasons were defined as:

- Seasonal: four seasons: spring = March – May, summer = June – July, autumn = September – November, and winter = December – February.

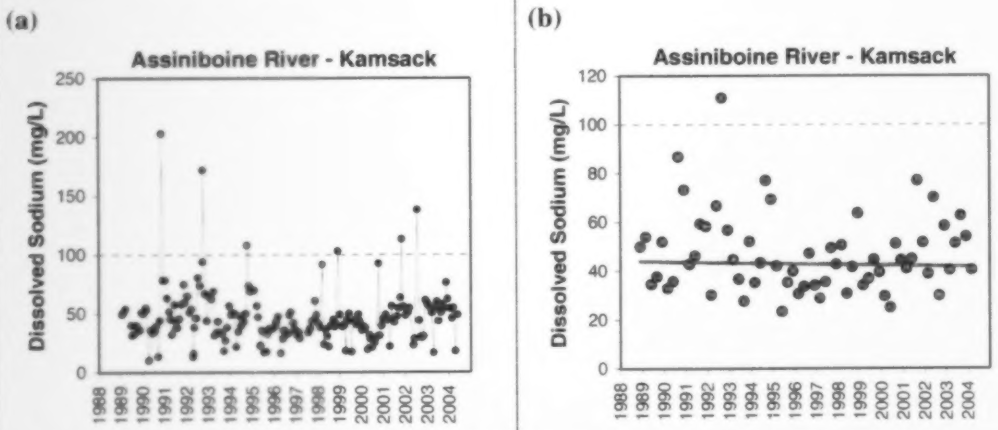
- Biannual: two seasons: summer = May – October, Winter = November – April.

Appendix 2: Trend Analysis.

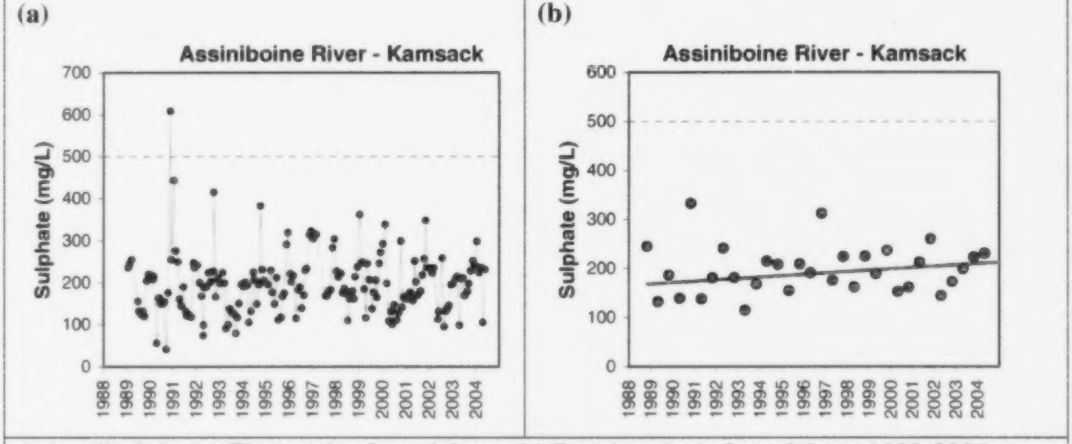


Appendix 2-1: (a) Time series for dissolved chloride; (b) Trend analysis for dissolved chloride, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.528, slope = -0.141 mg Cl^-/L/year.

Dashed line represents the objective concentration of dissolved chloride for aquatic life.

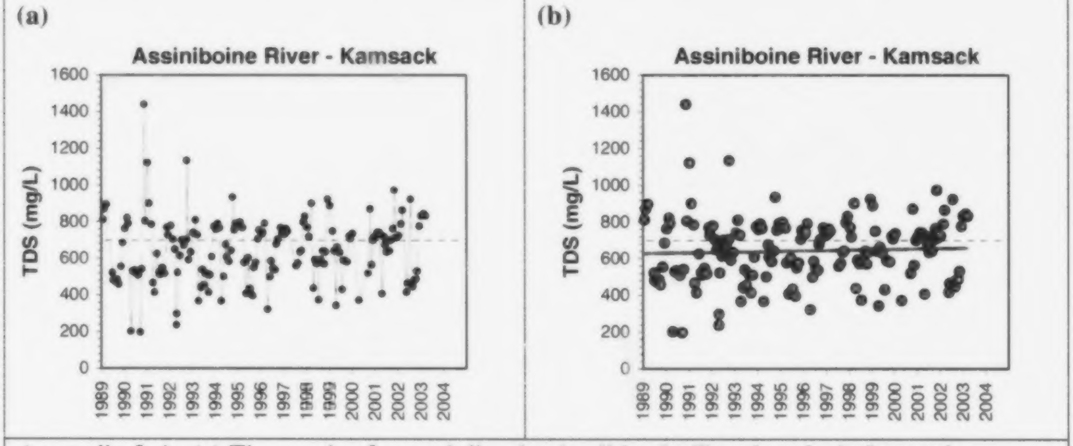


Appendix 2-2: (a) Time series for dissolved sodium; (b) Trend analysis for dissolved sodium, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.3061, slope = -0.1478 mg Na^+/L/year.
Dashed line represents the objective concentration of dissolved chloride for aquatic life.



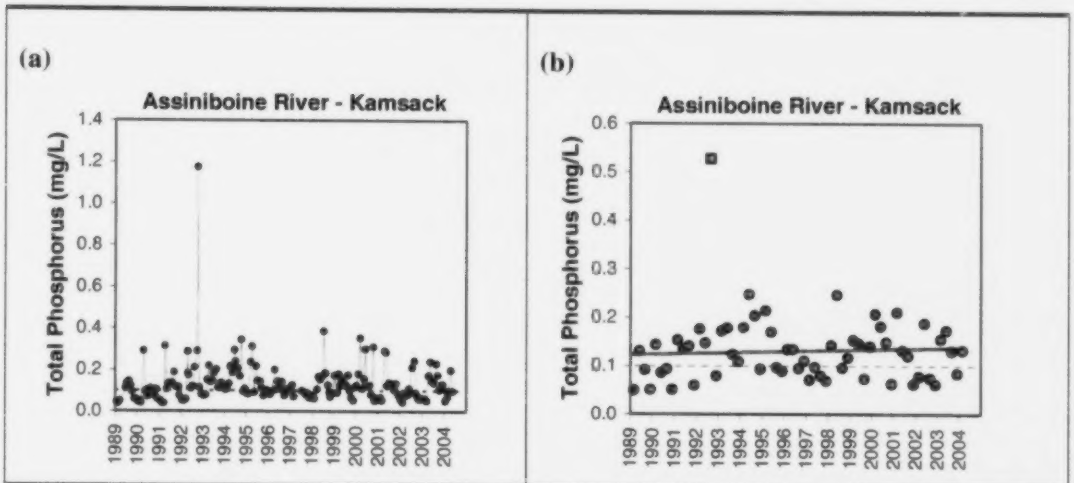
Appendix 2-3: (a) Time series for sulphate; (b) Trend analysis for sulphate, 1989-2004. Data were collapsed to two-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.9869, slope = 2.775 mg SO_4^{3-}/L/year.

Dashed line represents the objective concentration of sulphate for aquatic life.



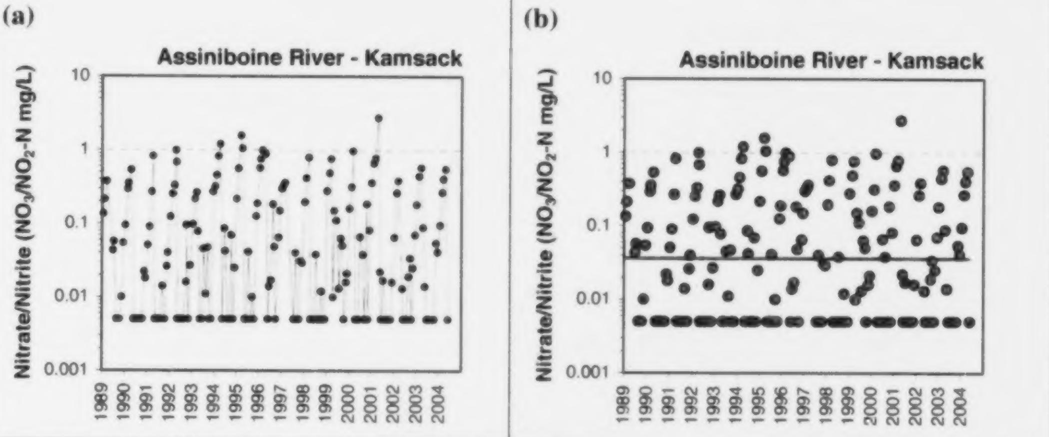
Appendix 2-4: (a) Time series for total dissolved solids; (b) Trend analysis for total dissolved solids, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.9015, slope = 2.082 mg TDS/L/year.

Dashed line represents the objective concentration of total dissolved solids for aquatic life.



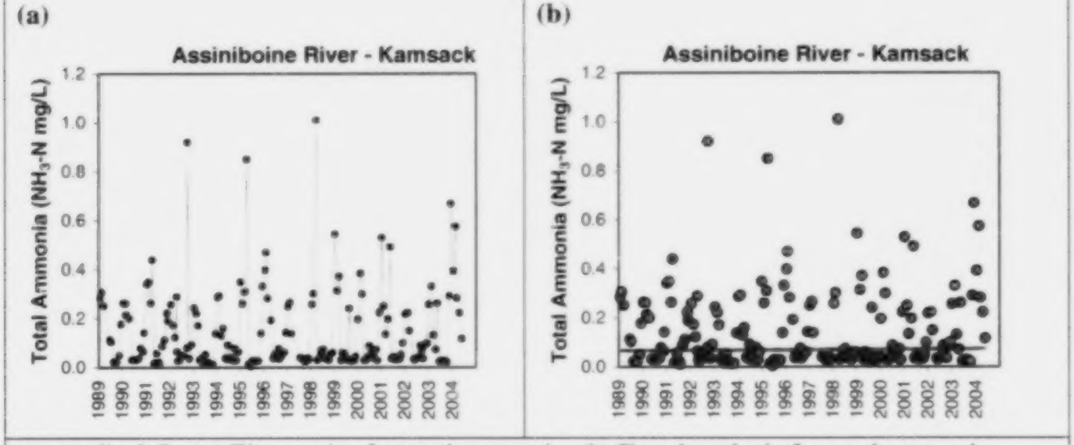
Appendix 2-5: (a) Time series for total phosphorus; (b) Trend analysis for total phosphorus, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. One outlier was removed (square symbol). The trend was not significant ($\alpha=0.05$). Mann Kendall normal approx = 0.479, slope = 0.001 mg TP/L/year.

Dashed line represents the objective concentration of total phosphorus for aquatic life.



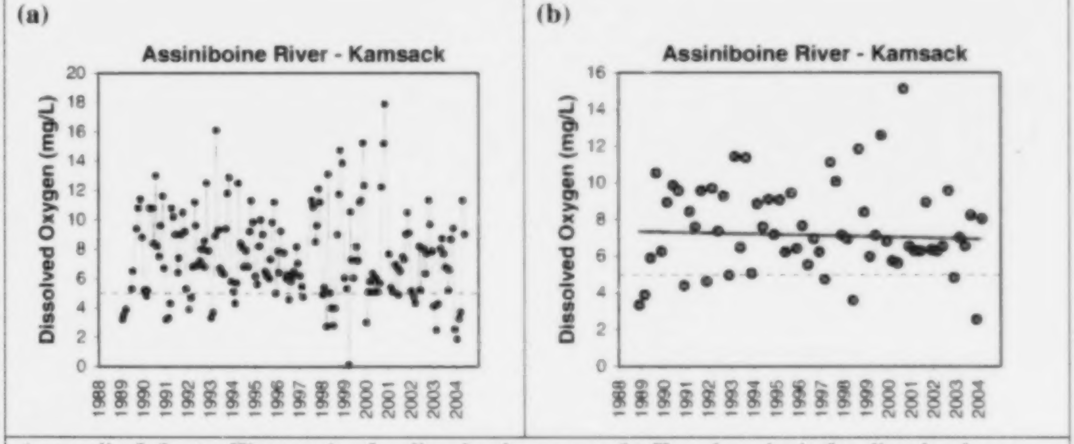
Appendix 2-6: (a) Time series for nitrate/nitrite as N. Note log scale; (b) Trend analysis for nitrate/nitrite, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant ($\alpha=0.05$). Mann Kendall normal approx = 0.6067, slope = 0.0 mg NO_3^-+NO_2^--N/L/year.

Dashed line represents the objective concentration of nitrate/nitrite for aquatic life.



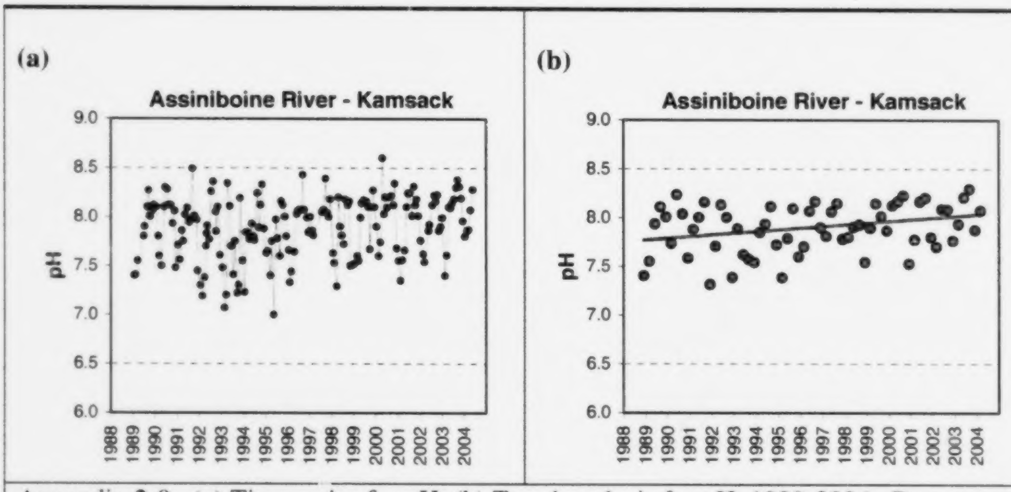
Appendix 2-7: (a) Time series for total ammonia; (b) Trend analysis for total ammonia, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 0.7988, slope = 0.000499 mg NH_3+NH_4^+/L/year.

Objective concentration of total ammonia for aquatic life varies with temperature and pH.



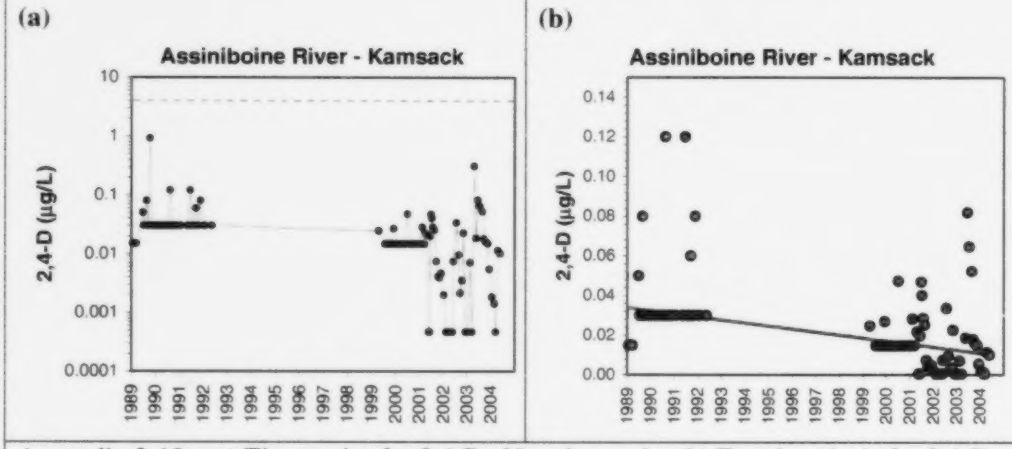
Appendix 2-8: (a) Time series for dissolved oxygen; (b) Trend analysis for dissolved oxygen, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = -0.4984, slope = -0.02702 mg O_2/L/year.

Dashed line represents the objective concentration of dissolved oxygen for aquatic life. Values above the line (i.e. >5 mg O_2/L) meet the provincial standards.



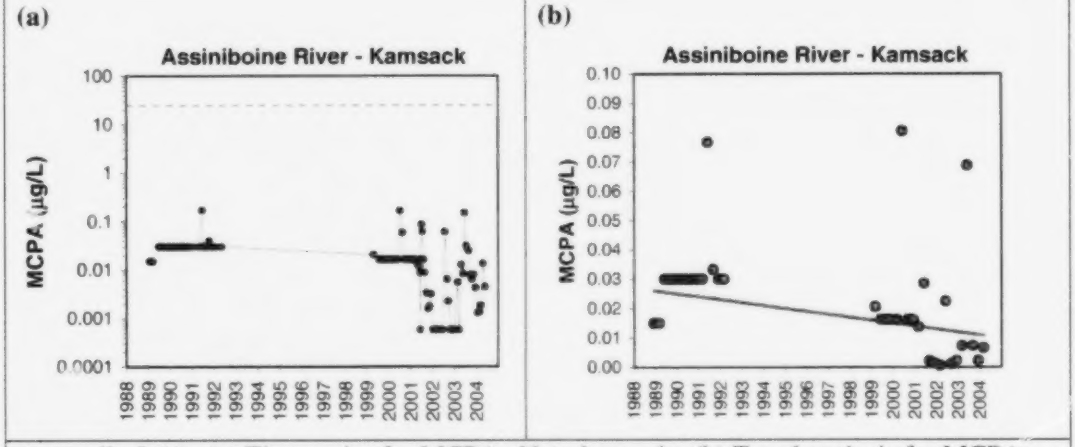
Appendix 2-9: (a) Time series for pH; (b) Trend analysis for pH, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was significant (α=0.05). Mann Kendall normal approx = 3.134, slope = 0.01737 pH/year.

The region between the dashed lines represents the water quality compliance region for aquatic life.



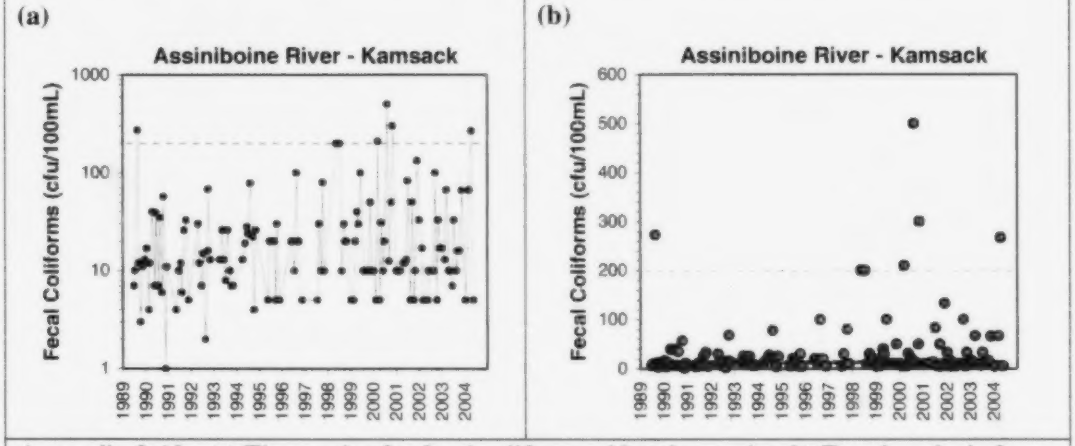
Appendix 2-10: (a) Time series for 2,4-D. Note log scale; (b) Trend analysis for 2,4-D, 1989-2004. Analysis was conducted using individual measurements. There was significant seasonality, so analysis was conducted using a Seasonal Kendall. The trend was significant (α=0.05); however, changes in the detection limit may be largely responsible for this significant trend. Mann Kendall normal approx = -5.201, slope = -0.00153 µg 2,4-D/L/year.

Dashed line represents the objective concentration of 2,4-D for aquatic life.



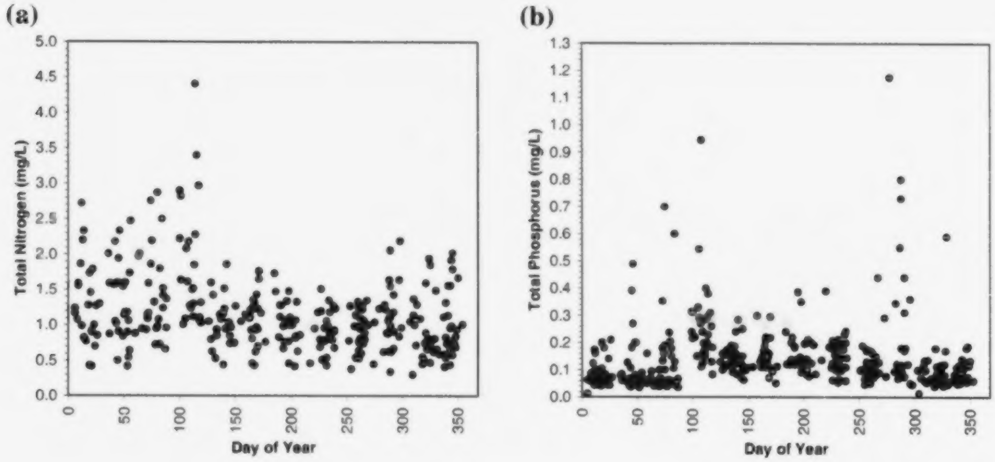
Appendix 2-11: (a) Time series for MCPA. Note log scale; (b) Trend analysis for MCPA, 1989-2004. Data were collapsed to four-x seasonal means due to serial correlation. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was significant (α=0.05); however, changes in the detection limit may be largely responsible for this significant trend. Mann Kendall Z = -230, slope = -0.001 µg MCPA/L/year.

Dashed line represents the objective concentration of MCPA for aquatic life.

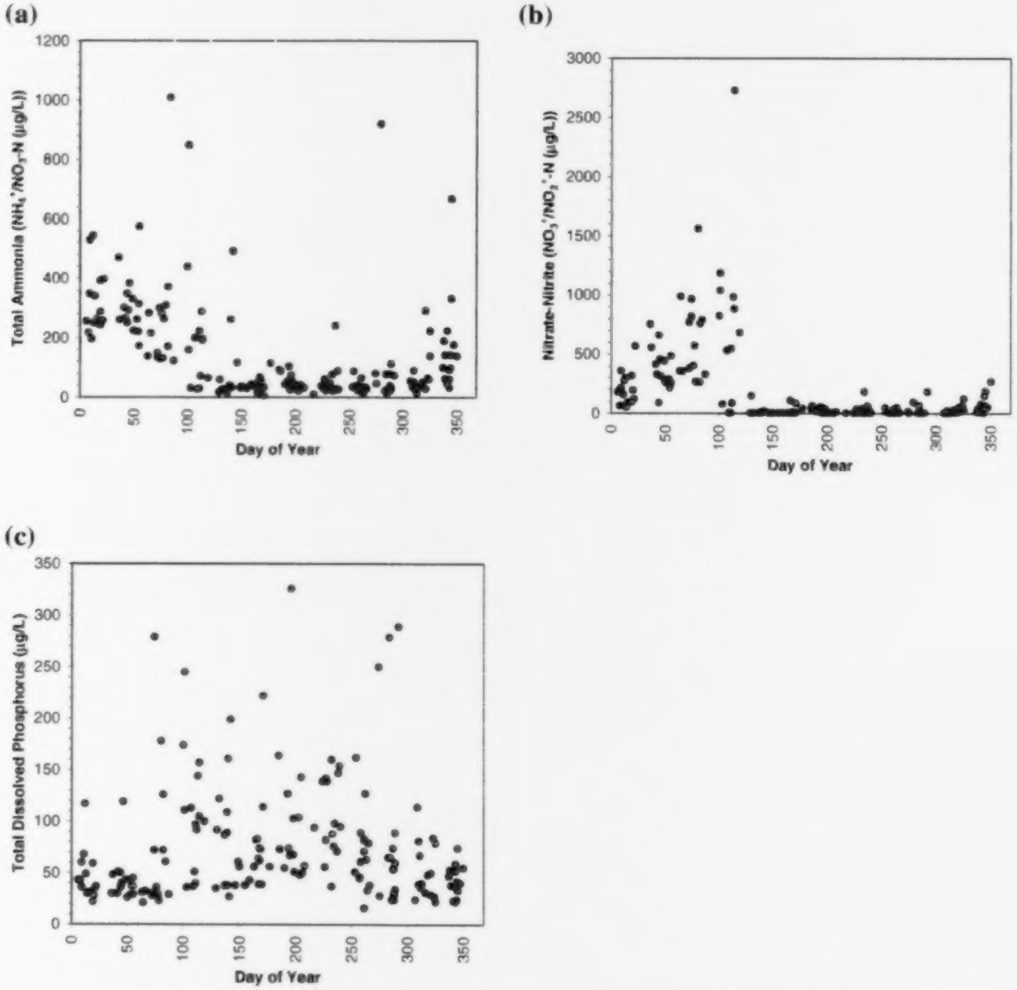


Appendix 2-12: (a) Time series for fecal coliforms. Note log scale; (b) Trend analysis for fecal coliforms, 1989-2004. Analysis was conducted using individual measurements. There was no significant seasonality so analysis was conducted using the Mann-Kendall. The trend was not significant (α=0.05). Mann Kendall normal approx = 1.21, slope = 0.101 cfu/100mL/year.

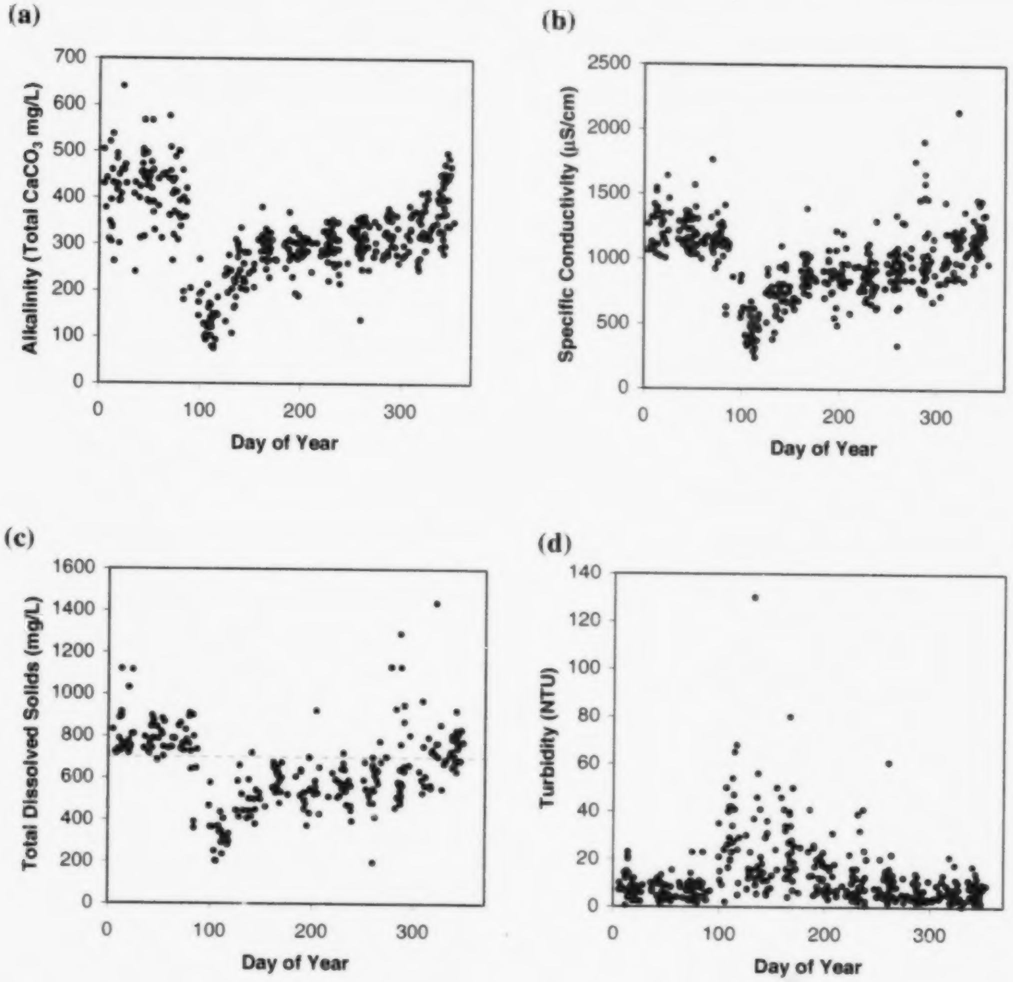
Dashed line represents the objective criteria of fecal coliforms for aquatic life.



Appendix 3-1: Assiniboine River seasonal trends at Kamsack for (a) total nitrogen; and (b) total phosphorus. 1989-2004.



Appendix 3-2: Assiniboine River seasonal trends at Kamsack for (a) total ammonia; (b) nitrate/nitrite; and (c) total dissolved phosphorus. 1989-2004.



Appendix 3-3: Assiniboine River seasonal trends at Kamsack for (a) alkalinity; (b) specific conductivity; (c) total dissolved solids; and (d) turbidity. Dashed line in (c) represents the objective concentration of total dissolved solids for aquatic life. Where available, data from 1968 – 2004.